TO EVALUATE THE EFFECT OF CONTINUOUS IRRIGATION AND SUCTION TECHNIQUE BY USING ANTIBIOTIC SOLUTION IN THE TREATMENT OF CHRONIC OSTEOMYELITIS

THESIS

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C E R T I F I C A T E

This is to certify that the work entitled "TO EVALUATE THE EFFECT OF CONTINUOUS IRRIGATION AND SUCTION TECHNIQUE BY USING ANTIBIOTIC SOLUTION IN THE TREATMENT OF CHRONIC OSTEOMYELITIS" has been carried out by Dr. Niraj Jain himself in this department.

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The techniques embodied in this work were undertaken by the candidate himself. The results and observations were checked and verified by me periodical

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C E R T I F I C A T E

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Dated:

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INTRODUCTION

INTRODUCTION

Infections pose a great challenge to a clinician from the time immemorial and since the same moment clinicians have been trying their best to wipe out this problem.

After the invention of antibiotics, it was thought that the infections could be controlled and infact it had almost done. But there still remains a type of infection against which we are still fighting and several experimental studies have been done in the current century expecially to conquer the battle. That problem is the infection of bones and this challenge further hightens, if the infection is a chronic one, i.e. chronic osteomyelitis.

Large quantities of antibiotics are used every year for the treatment of chronic osteomyelitis, but a number of patients return periodically with flair-ups and recurrent discharging sinuses. One of the difficulties in the treatment of chronic osteomyelitis by chemotherapy is the relative isolation of the infected tissue.

Chronic osteomyelitis is more a disease of chronic ischaemia than one of chronic sepsis. Involved areas of bone demonstrate organisms trapped in cancellous spaces by fibrin clot. Portions of cortex and marrow may show sequestration. The fibrin clot not

only protects the host from the organisms, but along with the avascularity buffers the organisms from the body's defence mechanisms.

Sir Alexander Fleming observed that locally applied chemotherapeutic agents are unable to sterlise a chronically infected wound.

On the other hand, the early stages of acute haematogenous osteomyelitis present a problem of altered vascular permeability and increased medullary pressure. The problem of ischemia is not encountered until medullary pressure is sufficient to obstruct nutrient artery flow. This apparently requires 3 to 5 days. When treatment is started after the 3rd day, the chance that one is dealing with an early chronic osteomyelitis is increased greatly.

The disease only does not cause agony and discomfort to the patients but also poses as a social problem being a great drain on the human resources and deteriorating the social status by inhibiting the earning capability of already poor class of persons who are main target of the disease.

The problem is further aggravated by psychosocial trauma to the patient due to functional disability caused by persistant foul smelling discharge from sinuses, constant suffering and chronic bed confinement. The problem is still made worse by the

common occurrence of compound fractures which are most common cause of chronic osteomyelitis.

Exogenous or post traumatic osteomyelitis is a primary local affection characterised by avascularity because of trauma itself. As this type of osteomyelitis represents both as ischaemic and infective problem since very begining there are fair chances for its conversion into the chronic osteomyelitis. However, provided proper surgical debridement is done, in most of these cases osteomyelitis occurs primarily because of the contamination of the wound accompanied by loss of skin and adjacent soft tissue.

The rapid modernisation and industrialisation and road side accidents are the major catalysts behind this scene.

The history of the treatment of chronic osteomyelitis is full of disappointments. Complete resolution occurs in many other types of infection with the use of antibiotics, but not always with chronic osteomyelitis. This failure must be due to the inherent nature of the bone lesion. Two processes are present : destruction and repair. Destructive processes are seen in the form of cavities containing granulation tissue, pus, organisms, sequestra and fibrous tissue. The reparative process is seen in the formation of new bone, often sclerotic and poorly vascularized. The infective

organisms are wide spread in this and in the adjacent cavities and sequestra, and these are relatively isolated from the blood circulation and parenterally administered antibiotics.

Treatment of chronic osteomyelitis can be satisfying experience for the surgeon who understands the basic pathologic process. The primary treatment of any infection is appropriate antibiotics in adequate dosage, coupled with efforts to improve the body's defence mechanisms. Treatment failures are usually due to the inability to deliver adequate doses of antibiotics at site of infection. Dead bone acts as a reservoir for bacterial growth and the dense scar tissue which surrounds the infection serve as an impermeable compartment to circulating antibiotics.

Even after removal of dead tissue and sequestra, excision of sinuses and saucerisation the dead space left behind is filled up by haematoma which acts as a potential site for the infection. If haematoma and dead space are controlled by open packing, there is opportunity for cross infection.

Elimination of dead space and prevention of cross infection have been essential features of established methods of treatment.

The general principles of previous methods of treatment can be summarised as follows :

1. Mobilization of host mechanisms, including rest.
2. Radical debridement of involved tissue.
3 Elimination of haematoma (dead space).
4. Prevention of cross contamination and recontamination.
5. The use of antibiotics to decrease mortality and morbidity and to aid local host mechanics.

Continuous irrigation-suction technique incorporates all principles of treatment :

- With the patient at bed rest, host defence are mobilised.
- Radical debridement eliminates involved tissue.
- Dead - space haematoma is controlled both physically by the irrigating solution and by certain possible physiologic mechanisms.
- Primary closure of skin and soft tissues prevents cross contamination and re-infection.
- The presence of antibiotics in the irrigating solution aids local host mechanisms.

This process was first introduced by Dumam and Carrel (1917). This method of treatment was first employed in the united states in its current term by Mc Elvenny. Its use in Germany since the mid 1950's has been reported by Willenegger and Roth.

It is the treatment of choice in all cases of established chronic osteomyelitis and all cases of acute hematogenous osteomyelitis warranting medullary decompression.

That is why we performed the present study to evaluate the effect of continuous irrigation-suction technique in the treatment of chronic osteomyelitis by using antibiotic solution.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Osteomyelitis is inflammation of all components of bone i.e. inflammation of cortex, medullary canal and presence of Periostitis.

Chronic non-hematogenous osteomyelitis defined as a bone infection that persists for more than six weeks after the initiating episode, with persistently exposed bone, continued drainage, and positive culture of material taken from the bone (May Jr. et al, 1982).

Chronic osteomyelitis can be defined as "One or more foci in bone that contain pus, infected granulation tissue, sequestra, a draining sinus, and resistant cellulitis" (Andrew J Weiland, MD, J. Russell Moore MD et al, 1984).

The inflammatory foci are surrounded by sclerotic bone with poor blood supply and are covered by a thick relatively avascular periosteum, scarred muscle and subcutaneous tissue. Antibiotics reach such tissue mainly by diffusion. Sensitive organisms may survive and become active again after the therapy is discontinued. Secondary infection with organisms that are more resistant to antibiotics than the primary infecting agent is not uncommon (Fitzgerald Jr., 1983). This changing pathogenesis of chronic osteomyelitis may account for the therapeutic failures that are often seen despite the extensive array

of antibiotics presently available (Fitzgerald Jr., 1979 and O'Riordan, Colm et al, 1972).

The voluminous literature on the subject clearly indicates that none of the methods available for its treatment today is entirely satisfactory. To begin with the ancient methods of putting seeds in the wound to enhance pus formation, upto present day trials of magnetism and iontophoresis have not shown satisfactory results and the disease is as dreaded as before.

INCIDENCE OF OSTEOMYELITIS

West et al (1970) said that femoral and tibial osteomyelitis represent 77% of all osteomyelitis seen by the orthopaedic surgeon.

Kelly (1977) described that incidence of chronic haematogenous osteomyelitis for the year 1951 through 1961 accounted for 44% of osteomyelitis of femur and tibia. Acute haematogenous osteomyelitis is uncommon in adults. However, acute osteomyelitis in drug addicts, especially with involvement of spine, has been reported (Wiessenman et al, 1973).

Occurrence of osteomyelitis with non union fractures in 40% cases described by Kelly. Osteomyelitis is most common in the long bones, particularly lower extremities (Waldvogel et al, 1970 and Edeiken et al, 1973). In neonates, multiple sites of infection are relatively common. Vertibral involvement is next common site in adult (Dalinka et al, 1975 and Wald et al, 1980).

The spine is a common site for infection in drug addicts (Kido et al, 1973 and Salahuddin et al, 1973) and in patients with septicemia, including bacterial endocarditis (Mund et al, 1980).

An increased incidence of osteomyelitis occurs in systemic disease, including diabetes (Friedman and Rakow, 1971) and Sickele cell disease (Reynold, 1977).

Patients with osteoporosis have an increased incidence of mandible and maxillary osteomyelitis (Gwinn and Free et al, 1972). Patients with insensitivity to pain like diabetes, leprosy also have an increased incidence of osteomyelitis.

PATHOPHYSIOLOGY

Trueta and others (Dalinka et al, 1975; Engh et al, 1976 and Wald et al, 1980) have divided osteomyelitis into three types that are based upon the variations in the metaphyseal blood supply in different ages. In the neonate and the adult, vascular communications are present between the epiphysis and metaphysis. In childhood (1 to 16 years), the epiphyseal plate separates the metaphyseal and epiphyseal vascular supply and acts as a barrier to the spread of infection. The periosteum is loose in the newborn infant and becomes more tightly applied to the cortex with increasing age.

In neonates, osteomyelitis frequently spreads to the adjacent joint and produces potentially permanent growth aberration. Extensive periostitis is frequently

present. In childhood, the epiphyseal plate acts as a barrier to infection and joint involvement is less common. Periosteal new bone formation may be extensive. In adults (After closure of epiphysis), joint involvement may occur, but periosteal new bone formation is considerably less prominent.

The medullary canal of the metaphysis is the most common site for hematogenous osteomyelitis. The pus formed within the metaphysis may obstruct the vascular channels and extend into the Haversian systems and Volkmann canals. The avascular infected fragments of dead bone are called "Sequestra" (Waldvogel et al, 1970). When the infection extends through the periosteum, exuberant periosteal reaction with new bone formation (involucrum) results. Although hematogenous osteomyelitis is most often seen in childhood, there has been a definite shift towards later onset (Vasly and Waldvogel, 1980). When the metaphysis is within the joint capsule, septic arthritis frequently accompanies osteomyelitis. This is particularly common in the hip or shoulder. Waldvogel found that the incidence of hematogenous osteomyelitis is decreasing and has accounted for only 19% of patients with osteomyelitis seen in the last 10 years. Osteomyelitis may also occur secondary to trauma or inoculation (i.e. drug addicts) or by direct extension from adjacent soft tissue infection. In these patients, infection may occur in any part of any bone.

Osteomyelitis may occur secondary to spread from adjacent soft tissue infection. This is particularly

common in patients with neurologic abnormalities and paraplegia. Osteomyelitis can follow penetrating trauma or open fractures.

Trivial trauma has been reported upto 30% of patients with osteomyelitis(Aegerter and Kirkpatrik, 1975 and Waldvogel et al, 1970).

Osteomyelitis can also occur in Pintrak (Stuart A green and Magaret J. Repley, 1984).

Osteomyelitis is also seen after certain surgical intervention like osteomyelitis of Pubis after radical hystrectomy operation (Udo B. Hoyme et al, 1984). Kejlowski et al (1983) reported 5 cases of multifocal chronic osteomyelitis of unknown etiology. In all cases biopsy confirmed the diagnosis but no pathogen was found.

MICROBIOLOGY OF OSTEOMYELITIS

Hematogenous osteomyelitis is usually caused by gram positive organisms, most common being Staphylococcus aureus (Aegerter et al, 1975, Waldvogel and Vasey, 1980).

Kelly (1977) reported that predominant organism cultured was Staphylococcus aureus in about 40% patients of chronic osteomyelitis.

Group B Streptococcus haemolyticus is a common cause of neonatal osteomyelitis. Gram negative organisms, Pseudomonas aeruginosa and Klebsiella pneumoniae, have been reported in intravenous drug abusers(Kido et al, 1973). Gram negative organisms can also be seen in hospital

acquired infection (Grieco, 1972). Other common gram negative organisms include Proteus mirabilis, Enterobacter Sp. and Escherichia coli(Kelly, 1977).

The remaining category includes anaerobic organisms such as Corynebacterium diphtheriae or Propionibacterium acnes (Morrey et al, 1977).

Opportunist organisms, including Candida albicans can be cultured from drug addicts, patients with diabetes mellitus (Hirschmann and Everett, 1976), immunosuppressed patients on long term antibiotic therapy and premature infants (Svirsky-Fein et al, 1980). There is an increased incidence of salmonella osteomyelitis in patients with Sickle cell disease. Disseminated fungal infections including coccidioidomycosis (Dalinka, Dennenberg et al, 1971), blastomycosis (Riegler et al, 1974), and actinomycosis may have osseus involvement in addition to pulmonary and cutaneous manifestations.

DIAGNOSIS OF CHRONIC OSTEOMYELITIS

May et al,(1982) described various clinical features of chronic osteomyelitis secondary to trauma or surgery as "a bone infection that persists for more than six weeks after initiating episode, with persistently exposed bone, continued drainage and positive culture of material taken from the bone".

Andrew J. Weiland et al (1984) described clinical features of chronic osteomyelitis in definition as "one or

more foci in bone that contain pus infected granulation tissue, sequestra, a draining sinus, and resistant cellulitis". Pus culture and sensitivity is very helpful for the treatment of chronic osteomyelitis in selecting the effective antibiotic.

Erythrocytic sedimentation rate (ESR) which is raised in osteomyelitis is also helpful to assess the course of the disease.

Radiography is very helpful for the diagnosis of chronic osteomyelitis. Capitanio and Kirkpatrik(1970) have described that earliest change in the oesteomyelitis is deep soft tissue swelling which occur within 3 days of the onset of infection. It is characterised by the displacement of the fat lines that are normally parellel to the bony surface. 3-10 days following infection, there is muscular oedema and obliteration of the normally seen thin planes of fat. At the end of this time period superficial subcutaneous oedema is also identified. The earliest osseous manifestations reflect hyperemia and trabecular destruction. Periostitis may be seen as early as 3 or as late as 6 weeks following the onset of infection (Edeiken and Hodes, 1973). Periosteal new bone formation can be lamellated or solid. Solid periosteal new bone formation is typical of benign lesions (Edeiken and Hodes, 1973). Small periosteal 'bumps' may be seen with granulomatous inflammatory disease (Edeiken and Hodes, 1973).

The infection enters the chronic phase as the periosteal new bone proliferates to become the involucrum

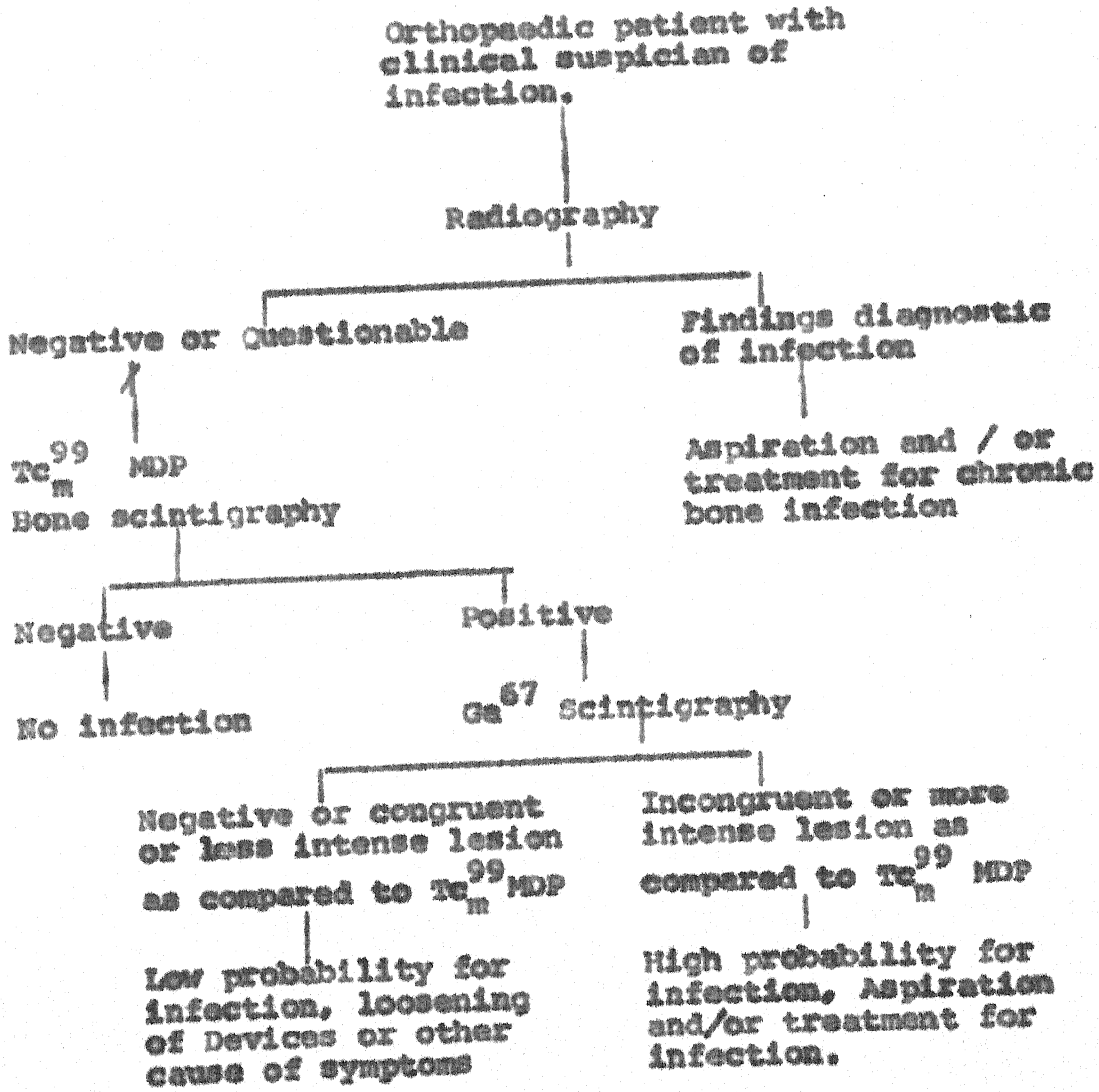
which eventually completely surrounds the shaft. Holes or skip areas within the involucrum called "Cloacae". Abscess may appear as soft tissue masses obliterating the intervening fat, which differentiate them from tumours, which usually displace the fat planes (Murry and Jacobsen,1977). Sequestra represent area of dead bone isolated from the blood supply. They can be very small or as large as the entire diaphysis (Murry and Jacobsen, 1977). Sequestra and involucra usually take at least three weeks to appear.

Bone scanning has had a tremendous impact on the radiologic evaluation of osteomyelitis. Positive scans may be seen as early as 24 hours following the onset of infection The bone scan is uniformly abnormal in chronic osteomyelitis but scan remain abnormal until bone healing and remodelling is complete (Howie et al, 1983). In this situation scanning with Ga^{67} or labelled leucocytes may be helpful in separating such reparative changes from continuing infection (Woolfenden et al, 1980).

Wajih Al-Sheikh et al (1985) used In^{111}, Ga^{67} and Tc_m^{99} metadiphosphonate bone scintigraphy for the diagnosis of subacute and chronic bone infections. Scintigraphy was done 24 hours after reinjection of autologous leucocytes labelled with 300-500 u Ci of ^{111}In oxine. Then patients were studied 3 hours after intravenous injection. 20 mCi of Tc_m^{99} MDP and 24-72 hours of Intravenous injection of 5 mCi of ^{67}Ga - citrate.

A normal or 'cold' area may be seen secondary to vascular compromise by pus. The cold area often indicates concomitant infection (Berkowitz and Wenzel,1980). Bone scanning is less accurate in neonatal osteomyelitis. This may be related to the unique anatomy and physiology of the metaphysis in that age group (Ash and Gilday,1980).

Al-Sheikh et al (1985) described following diagnostic procedure for an orthopaedic patient who is suspected of having chronic bone infection -



Computerised axial tomography (CAT) may be of value in patients with acute osteomyelitis. It can show the extent of medullary involvement even when the plain roentgenograms are normal (Kuhn and Berger, 1979). Soft tissue involvement is well seen on computed tomography(CT).

Vivian W. Wingh et al (1985) studied the CT changes in the 25 patients with acute exacerbation of chronic osteomyelitis. Scan were obtained at 5-10 mm. Sections isolated bony fragments within crotical defects or in adjacent medullary cavity were considered highly suspicious for sequestra.

OSTEOMYELITIS MANAGEMENT

Various methods with heavy doses of antibiotics are used every year for the treatment of chronic osteomyelitis, but a number of patients return periodically with flare-ups and recurrent discharging simuses, one of the difficulties in the conventional treatment of chronic osteomyelitis i.e. sequestrectomy and saucerisation with chemotherapy is the relative isolation of remaining infected tissue. Because bacteria may be wide spread in the Haversian canal or within the medullary cavity.

The use of antibiotics and sophisticated surgical therapy has decreased the mortality but not the prevalence of osteomyelitis (Waldvogel et al, 1970). Various methods have been attempted for eradication of the disease. Some workers have carried out this by local application of topical agents in the term of use of hot oil (Pare), sea sponges (Long, 1927), carbolic acid and

Bichloride of mercury, vaseline gauge, Maggots (Baer, 1931). Saline (Brockway, 1932) and bacterio-phages (Albee, 1933). Local chemical sterilization do as much injury to local host defence as to the bacteria and are ultimately advantageous to the later (Bryson and Mandell, 1964).

Orr (1927) was the first surgeon who logically applied the principle of rest and immobilization of the affected part in plaster of paris and augmented it with surgical debridement i.e. sequestrectomy, saucerisation and open packing of resultant cavity. Wound is allowed to heal by secondary intention.

This remained the treatment of choice of osteomyelitis for many years but this treatment had two major disadvantages - first the healing usually takes a longer time, second the healing takes place by granulation tissue which is later covered by thin epithelium and this epithelium is easily damaged.

ANTIBACTERIAL AGENTS IN THE MANAGEMENT OF OSTEOMYELITIS

Treatment of bone infections with antibiotics is one of the major advancement in the present century. Before the discovery of antibiotics, one third of the patients used to die of acute hematogenous osteomyelitis, and a high proportion of patients with chronic osteomyelitis came to amputation.

Kelly (1977) described a regimen of four weeks of parenteral antibiotic therapy. He claimed the success rate of 90% for chronic osteomyelitis in the categories of

or hematogenous infection, posteoperative osteomyelitis and osteomyelitis in the ~~/~~united fractures. But he himself said that it is difficult to prove that this success was attributable to a standardized regimen of antibacterial treatment. Major problem with the antibiotic therapy in the treatment of chronic osteomyelitis is the poor penetration of antibacterial agents in relatively avascular tissue and necrosed tissue or pus.

Though researches claim that Fucidin (Rowling, 1970) and Lincomycin (Hagen, 1978) may permeate in the tissue with relatively poor vascular supply and even in the pus. However none of the drug is going to completely cure the condition. Therefore antibiotics are having only supportive role and in no way can replace adequate surgical treatment

SURGICAL MANAGEMENT OF CHRONIC OSTEOMYELITIS

In surgical management of chronic osteomyelitis certain objectives are evident.

First is removal of any dead bone. Sequestra that if remained in a cavity will keep osteomyelitis smoulding for years. Often as a consequence of removal of dead devitalized and infected bone, a sizeable cavity or "dead space" will exist.

Second objective is consideration of method to obliterate any dead space. A method of obliteratimg dead space can be a very major aspect of the surgical considerations.

Third objective is to obtain soft tissue coverage of exposed bone.

Fundamentally, the surgical procedure is designed to obtain closure and obliteration of dead space when finely divided bone grafts of cancellous bone are employed to fill a saucerized cavity. The technique is termed as papineau-procedure (Papineau, 1973).

Bone Grafts

Lieutenant Coloney Marvin P. Knight et al (1945) described three stage method for the obliteration of bone cavities following traumatic osteomyelitis. The technique was employed extensively in World War II over army personnel injured (Rhinelander, 1975). Out of 23 cases they reported 21 cases have entirely healed wound.

Stage - I : Sequestrectomy is performed and cavity is prepared. Then the wound is kept open with vaseline gauze, and the affected extremity is immobilized.

Stage - II : Five to seven days later split thickness skin grafts applied over the granulation tissue present over the surface.

Stage - III : Obliteration of bone cavity with autogenous bone chips.

Principal factors in the success of this stage are :

1. Planning of suitable full thickness covering for the defect.

2. Complete excision of the split thickness covering from the depth of the saucerized area.
3. Procurement of a sufficient amount of bone chips to fill the cavity.
4. Covering of the chip filled cavity with skin and subcutaneous tissue in such a manner that tension is avoided.

This method appears promising for the most difficult osteomyelitis of the tibia and femour, the infections involving the ends of a long bone.

Disadvantage of this method is that it requires multiple surgical interventions.

Autogenous Bone Grafts

Coleman et al (1946) advocated a single stage procedure of saucerization, bone grafting and closure with reported success of 92% of 52 cases.

Prigge (1946) reported success in 16 out of 20 cases. He employed grafting with cancellous iliac bone.

Bickel et al (1953) with 36 cases, Hamlette (1954) with 101 cases, Poppirow (1960) with 60 cases, D. Oliviera (1971) with study over series of 120 cases used the autogenous cancellous bone grafts in the treatment of chronic osteomyelitis.

Papineau (1973) and Burri (1975) have reported favourable results using apparently paradoxical technique of grafting free autologous grafts of cancellous bone.

Homografts and Fibrin Adhesion

W. Lack, P. Bosch, and H. Arbes (1987) published their study of 29 bone defects caused by chronic osteomyelitis have been treated by radical excision of necrotic bone followed by packing the cavities with cancellous homografts held in position by a fibrin sealant. At follow up three years after operation all except one had healed. The removal from homografts of the cellular constituents, such as bone marrow and blood and their subsequent sterilisation by irradiation diminished their antigenicity (Burwell, 1964) and the introduction of fibrin adhesion system improves their recorporation and remodelling (B'osch et al, 1976 and B'osch, 1981).

CLOSURE OF OSTEOMYELITIC DEFECTS BY MUSCLE AND MUSCULOCUTANEOUS FLAPS

Stark (1946) was one of the earliest proponents of muscle flap transposition to cover osteomyelitic defects and Ger (1972) popularized the method and extended the indications to provide coverage for a variety of lesions in the leg. In recent years, the use of muscle and musculocutaneous flap transposition to provide vascularised soft tissue cover has resulted in successful treatment of patient with defects resulting from trauma and osteomyelitis (Ger, 1970 and Ger, 1977). James and Gruss (1983) used muscle and musculocutaneous flap for the closure of osteomyelitic defects in 7 patients and reported good result.

Advantages of muscle flap transposition include increased vascularity from locally available muscle which obliterates bone cavities and fill soft tissue defects, preventing leaking of exudate, allowing antibiotic to perfuse in infected area, permitting ready up take of split skin graft, and preventing adherence of skin to bone (Gor, 1977).

FREE TISSUE TRANSFER

Recent advances in the field of reconstructive microsurgery have made it possible to transfer free cutaneous, myocutaneous, muscle, bone and osteocutaneous flaps from one part of body to a recipient site that is deficient of such tissue. Blood supply is restored to the free graft at the transfer site by microvascular anastomoses of donor and recipient arteries and veins. This method predictably results in healing of osteomyelitis (Gordon and Buncke, 1983; Mathews et al, 1982 and May et al, 1982).

May Mr. and Savage (1983) stated in their report that osteomyelitis should be treated aggressively by a reconstructive microsurgeon. In 1982 May et al reported their results with microvascular transfer of free tissue in 22 patients with 100% success. The series was later expanded to 30 patients with only one failure.

Mathews et al (1982) described the use of free muscle flaps in 11 patients with chronic osteomyelitis with no recurrence of infection.

Gordon and Bunke (1983) described the results in 14 patients with osteomyelitis who had been treated with repeated debridements and free flap coverage. Two patients had recurrence of the infection.

Andrew, J. Weiland et al (1984) described 79% success in the 37 free tissue transfer.

ADJUVANT HYPERBARIC OXYGEN

Davis, J.C. recently reported (in press) the results of a follow up evaluation of 40 patients of chronic osteomyelitis who were treated with systemic hyperbaric oxygen as an adjuvant to debridement of the infectious focus in bone, as well as systemic administration of antibiotics. He reported that 75% of the original patients remained free of infection.

Morrey et al (1979) used hyperbaric oxygen in the treatment of chronic osteomyelitis. He published the series of 40 patients. Jefferson C davis et al (1986) described the use of adjuvant hyperbaric oxygen in the treatment of chronic osteomyelitis in 38 patients. They reported 34 patients with successful results. Patients were treated by local debridement of the wound, prolonged parenteral administration of antibiotics and once a day treatment with hyperbaric oxygen, for on an average 48 days.

SILVER IONTOPHORESIS

Use of electrically generated silver ions in treating chronic osteomyelitis was described by Becker

et al (1978), and Webster (1981). It has got both bactericidal as well as osteogenic properties.

TOPICAL ANTIBIOTIC - DETERGENT TECHNIQUE

Grace and Brayson (1945) were first to describe this method in cases of chronic osteomyelitis. They used Penicillin in sodium chloride solution along with wetting agent 'Tergitol'. He emphasized the non-operative treatment of wound, while Mitra used this technique after wound debridement. The one better aspect of this method is that it is simple and so can be widely used in those areas who are underdeveloped and without facilities of extensive surgery.

CONTINUOUS IRRIGATION AND SUCTION TECHNIQUE

The treatment of chronic osteomyelitis is very cumbersome, time consuming and unsatisfactory till date which signifies from the fact that several attempts to cure it, have been made starting from boiling water to various reconstructive operative procedures of today, but none is fool proof.

Now the question arises that why the chronic osteomyelitis is notorious one. First and the most importa the antibiotics could not reach at the site of infection. Thereby persistence of bacteria in that part of bone which is rendered avascular by them. Second, antibiotics could not transgress the area occupied by necrosed tissue and pus Third there occurs the thrombosis of subperiosteal vessels

and main nutrient artery thus blocking the way of antibiotics to infected part of bone.

Even after removal of dead tissue and sequestra excision of sinuses and saucerization, the dead space left behind is filled up by the haematoma providing a potential site for the infection.

If the collection of haematoma could be prevented in the cavity thus formed, the infection occurring subsequently will not take place and this brought the idea of the technique of continuous irrigation and suction. Doing irrigation by antibiotic solution the additional advantage would be the elimination of bacteria, residing in Haversian system and medullary canal.

This process was first practised by Duman and Carrel (1917).

In 1934 the first "drainage and irrigation cannulae" were made for the osteomyelitis service of the Massachusells General Hospital. These were stainght glass canulae, each with a flange at one end to prevent it from slipping out of the wound. After incision and drainage of an osteomyelitic area two of these cannulae inserted and at regular intervals irrigation fluid was allowed to flow through the wound. Glass was not ideal because of possibility of breakage, so in 1938, the vitallium cannulae were made. Smith Petersen (1945) used such cannulae for drainage and irrigation in the treatment of septic wounds by local chemotherapy with primary closure. They used Dakin's solution, silver - pectinate and Penicillin as local chemotherapeutic agents in irrigation fluids. Duration

of irrigation was 2 to 4 weeks. When irrigation was complete, cannulae removed under pentothal anaesthesia and soft tissue defects were closed. They also used systemic chemotherapeutic agents along the local chemotherapeutic agents.

In 1942 Brantigan and Owen reported the topical use of sodium tetradecyl sulphate in the treatment of acute pyogenic empyema of pleural cavity. This acts as detergent or "welling agent".

Grace and Bryson (1945) reported success in the topical use (in 3 cases of chronic osteomyelitis) of penicillin in a solution of isotonic sodium chloride with 0.1% of the detergent sodium tetradecyl sulphate.

In 1947, Grace and Bryson reported excellent results following the topical use of a penicillin detergent solution in treating 2 was veterans who had been discharged from millitary service with intractable osteomyelitis. In this same report they referred to their success in treating a series of 37 civilian patients who were suffering from chronic osteomyelitis.

During the decade following his first successful use of a detergent antibiotic solution, Grace and his co-workers were able to effect a cure of many cases of infection in vareity of bacterial organisms including the tubercle bacillus. Refinements in the technique included the closure of the wound before beginning instillation of the detergent antibiotic solution. Antibiotics which were soluble. in the solution and also previously determined

to be most effective in invitro tests were selected. Mitra of Calcutta, India worked with Grace in Brooklyn, and in 1957 they reported compete[1] arrest of 64.21% of 95 cases of chronic pyogenic osteomyelitis treated in Calcutta and 69% of the 45 similar cases treated at the Grace Clinic, Brooklyn, New York. In these cases the actual surgery performed consisted only of removal of sequestra and other grossly devitalized tissue and opening the medullary canal sufficiently to assure free entry of the detergent antibiotic solution. They used "Aerosol Wash" solution as detergent.

Edward L. Compere (1962) used above mentioned technique in the treatment of osteomyelitis and infected wounds by closed irrigation with a detergent antibiotic solution. He used 5 cc of the detergent antibiotic mixture. Instilled through the T-tube 3 times each day for 5 to 10 days. He reported that results are very gratifying which have been achieved in a small series.

Closed continuous circulation of a solution containing antibiotics was first used for patients on the orthopaedic service of Chicago Wesley Memorial Hospital Goldman, Johnson and Grossberg (1960) : resident surgeons in orthopaedic surgery described the technique and reported five cases of osteomyelitis which were cured by continuous or intermittent closed irrigation. The time elapsed between beginning circulation and healing of the wounds was from 1 to 6 weeks.

Mc Elvenny (1961) developed the detail technique described by Codman, Johnson and Grossberg. He reported 12 cases treated by this method. How ever its use in Germany since mid 1950's has been reported by Willenegger and Roth.

Dombrowski and Dunn (1965) reported the comparative study of the short term results of closed wound irrigation and suction technique with those obtained by the open packing method in another series of cases. They carried out 29 closed irrigation procedure of major bones in 22 patients. Results of these cases were compared with 16 open packing procedures. They claim that failure rate with open packing (43%) were higher than with closed irrigation (23%). More over they also mentioned that closed irrigation suction incorporated all previous principles of treatments : with the patient at bed rest, host defenses are mobilized. Radical debridement eliminates involved tissue. Dead space hematoma is controlled both physically by irrigating solution and by certain possible physiologic mechanisms. Primary closure of skin and soft tissues prevents cross contamination and recontamination. The presence of antibiotics in the irrigating solution aids local host mechanisms.

Dombrowski and Dunn (1965) postulated the following explanation of why prolonged irrigation may seem to substitute atleast in part even for inadequate debridement. There is an osmotic gradient of 15 m of Hg. between irrigation solution and interestitial fluid.

This includes a flow of fluid from tissue to wound cavity.

Second factor which helps the flow of fluid is temperature because temperature of tissue is about 37°C and that of irrigation fluid is about 25°C. This flow brings fresh lymph and leucocytes into the area which have antibacterial property and help in obliteration of dead space.

Dilmaghani et al (1969) described an improved method for closed system, irrigation-suction, antibiotic, detergent treatment of deep wounds. Most of the 24 patients in series had acute infections of the musculo-skeletal system and there were some chronic infections.

The method described in these papers, employs many of the time-honoured measures such as sequestrectomy and debridement, but particularly an effective closed irrigation-suction tube system. The use of cloropatic -XCB and a wide selection of antibiotics, whose local effect appears to be increased when they are combined with detergents (Alevaire)(Grace and Bryson, 1945; Mitra and Grade, 1956) directed with considerable precision to the involved parts, makes unnecessary and underirable wide spread removal of bone essential for structural stability. The suggested flow reversal technique to avoid plugging of tubes.

They claim the results as gratifying and severe residual crippling due to tuberculosis of hip joint in children may be prevented by this method.

Polo (1968) employed the irrigation-suction antibiotic detergent method in 8 children with tuberculosis of hip and 4 children with tuberculosis of knee and claimed favourable results.

Hall and Grossfield (1966) used this technique in the treatment of acute haematogenous osteomyelitis with marked success. They claimed that duration of this type of management could be reduced to only a few days

Taylor and Maudsley (1970) used a technique of closed instillation-suction for the treatment of chronic osteomyelitis in 12 patients. In their technique, infected bone is first exposed and all necrotic material removed. Three perforated drainage tubes are inserted. Closed continuous-instillation-suction thus established, and had been maintained for upto 6 weeks. They claim results as follows :

- In one patient method failed technically.
- In 8 cases out of 11 in which the infection was resistant to conventional treatment. There was clinical resolution of the infection with the instillation suction technique.

Lawyer et al (1972) described intermittent closed irrigation technique for treatment of osteomyelitis.

Michelinakis (1972) published the result of continuous-irrigation-suction method used for the treatment of chronic osteomyelitis in 12 patients. The

irrigation solution he used, composed of 800 cc normal saline, 200 ml Alevaire and 2 antibiotic according to the culture and sensitivity reports. He used Y-shaped tubes and one of the each Y tubes lies within the medullary cavity and other in the surrounding soft tissue. He described good results in 10 patients and they remained clinically symptom-free and there was no radiological evidence of infection fof 2 to 4 years.

He also mentioned that all the patients had previously failed to respond to conservative treatment with antibiotics, and immobilisation etc. and 8 of them had from 1 to 7 operations for the infection prior to irrigation (i.e. sequestrectomy, excavation of abscess etc).

Clowson, Davis and Hansen (1973) published their study based on treatment of chronic osteomyelitis with emphasis on closed suction-irrigation technique. Characteristic features of their work were :

1. They used different methods for the treatment of chronic osteomyelitis in 176 patients and results of treatment with suction-irrigation technique compared with patients treated by other types of surgery. The results had been considered by the 3 parameters namely drainage, pain and toxicity.
2. They mentioned the following important technical considerations in the use of suction-irrigation -

a. They placed tubes parallel, side by side to each other and tied both tubes to each other.

b. They recommended the irrigation flow rate of 1 to 2 litres per hour for the first 2 days.

c. To avoid frequent change of bottles they used renal dialysis unit.

d. They performed irrigation in 5 to 40 days.

e. They also gave emphasis over the good nursing and after care.

f. Initially detergent and antibiotics were used in the irrigation solution but later on they did not used them.

3. Results were published as follows :

a. Out of the patients treated with the suction irrigation method, 73.5% were asymptomatic at follow up as compared with 45% of those treated by other methods.

b. 80% of the patients treated with suction-irrigation were clinically improved by atleast one parameter as compared with 78% improvement in patients treated by other methods.

c. 47 patients underwent girdle stone Hip ortho-plasties 18 were treated open and 29 were treated by closed suction-irrigation method. Of the 18 treated without suction irrigation, only 8% were asymptomatic at follow up and only 69% were clinically improved by at least one paramster.

Of the 29 patients treated with suction irrigation, 74% were asymptomatic at follow up and 97% were improved clinically by atleast one parameter.

Letts and Wong (1975) treated 18 cases of acute osteomyelitis with closed tube irrigation and their results were compared with a similar group in which the treatment was the same except for the omission of closed tube irrigation (Incision and drainage etc.).

They mentioned that technical complications were developed in 13 of the 18 patients, in whom closed tube irrigation was used. Post operative hospitalization was almost double in case of closed tube irrigation than that of treated with other method.

They concluded that the end result of treatment of acute osteomyelitis with closed tube irrigation is little different from that of simple incision and drainage and antibiotics. And suction irrigation in the treatment of acute osteomyelitis in children does not appear to be essential for successful management and introduced added risks of superinfection and technical complications.

Compere, Metzgeg and Mitra described treatment of pyogenic bone and joint infections by closed irrigation (circulation) with nontoxic detergent and one or more antibiotics.

Rao and Sahu (1978) compared the results of 18 patients of chronic osteomyelitis treated with suction

irrigation technique with those 30% treated by conventional methods like : sequestrectomy, saucerization or both. The irrigation fluid was normal saline with the appropriate antibiotic. Of the patients treated with suction-irrigation technique 77.7% were asymptomatic at follow up as compared with 43.3% of those treated by other methods. Poor results from the use of closed suction irrigation is usually from one or more causes as stated by Clowson et al (1965-1973). Inability to remove all the dead bone and surrounding scar tissue, failure to understand the principles of suction-irrigation system and technical failures of surgical and nursing team.

Bajaj et al (1981) described the results of treatment of chronic osteomyelitis with continuous irrigation suction technique in 30 cases. In this series majority of cases had involvement of long bones. They used irrigation fluid normal saline and one or two antibiotics according to culture and sensitivity reports. They used 1000-1500 ml of irrigation fluid in 24 hours duration of irrigation ranged from 4 to 14 days.

The most common causative organism was staphylococcus aureus. It may present alone or in combination with other organisms in 75% of the patients with positive culture.

Similarly, Staphylococcus as a major cause of osteomyelitis had been reported by other workers (Mitra

and Grace, 1956; Mercer, 1959; Michelinski, 1972; and Rao and Sahu, 1978). Bajaj et al evaluated the results as "excellent" when there was healing by primary intention, no sinus or residual infection, no pain or local tenderness "good" when there was delayed wound healing or occasional pain and tenderness but no residual infection or sinus; and "Poor" when there was persistent pain or discharge.

The results of their series were excellent in seven, good in 15(together 73.3%) and poor in 8(26.7%).

They mentioned the advantages of suction-irrigation technique as : almost complete prediction that the operative wound will heal by primary intention-infrequency of dressing, reduction in the time for complete healing, minimum loss of serum, no soiling of bed linen, comfort and lack of systemic reaction, reduction in cross infection, hospitalization and post operative isolation. Metalic intramedullary fixation may be left in place or inserted at the time of operation.

MATERIAL AND METHODS

MATERIAL AND METHODS

In the present study, a concerted effort has been made to evaluate the effect of continuous irrigation and suction technique by using antibiotic solution in the treatment of chronic osteomyelitis.

Cases of all age groups having chronic osteomyelitis of different bones coming from peripheral areas of Jhansi and other adjoining districts were included in this study. These were admitted in the department of Orthopaedics, Maharani Laxmi Bai Medical College, Hospital, Jhansi (U.P.) where study was carried out.

CRITERIA FOR THE SELECTION OF CASES

- Patients having pus discharging sinus with radiographic findings suggestive of chronic osteomyelitis.
- Fresh cases as well as cases of chronic osteomyelitis treated previously by other methods (whether conservative and / or operative like incision and drainage sequestrectomy, saucerisation etc) have been included in present study.
- Patients of chronic osteomyelitis without sequestrum.
- Patients of chronic osteomyelitis where saucerisation is not possible due to lack of strength of the bone.

Patients not turning up after operation or having follow up period of less than 2 months were not included in this study.

PRE-OPERATIVE EVALUATION AND PREPARATION

All the cases were thoroughly interrogated for detailed history, examined clinically and properly investigated before any surgical intervention. Probing of the sinus remained an essential step in the clinical examination.

Various investigations done were as follows :

1. Blood routine : Hb%, TLC, DLC, ESR.
2. Urine routine : Albumin, Sugar, Microscopic examination.
3. Blood Sugar : Fasting and postprandial or random.
4. Blood urea.
5. Pus culture and sensitivity.
6. Antero-poterior and lateral skiagrams of affected part.

Pre-operative tetanus toxoid and antitetanus serum were given in all cases. Systemic antibiotics were given pre-operatively according to the culture and sensitivity repart and if pus culture and sensitivity could not be done then crystalline peniccilline and Gentamicin were given.

In general debilitated patients their general condition was improved by oral or parentral iron therapy or by blood administration along with protein rich diet and vitamin preparations. For the selected cases blood was also arranged for per-operative

transfusion. Only then operations were carried out when patient become fit for anaesthesia.

Proper pre-operative preparation of the part was started well in advance. Twenty four hours before the operation methyline blue dye was injected in sinus, to detect the exact sinus tract per-operatively in selected cases.

Skiagrams of the patients were thoroughly studied along with clinical examination to assess which procedure is to be carried out viz. dril holes, saucerization, sequestrectomy, syringectomy etc. along with irrigation and suction.

OPERATIVE TECHNIQUES

Under appropriate anaesthesia (either general or regional) operation was performed as single stage procedure under strict aseptic conditions.

- Part was first painted and drapped.
- With the help of a probe direction and depth of sinus was determined.
- Suitable incision was made considering the condition of skin, presence of scar tissue and site of sinus.
- Diseased bone was reached by appropriate approach and widely exposed.
- Assessment of condition of bone and surrounding soft tissues was made.
- All fibrosed and necrosed soft tissue, sinus, tract, unhealthy granulation tissue and sequestrum present

were removed.

- Saucerization of the cavity if present was done.
- Medullary canal on both sides was opened.
- Per-operative pus specimen was collected and sent for culture and sensitivity.
- The cavity present was curetted.
- Then wound was thoroughly irrigated with copious amount of normal saline to remove all the debris and blood clots.
- In the cases where saucerization was not possible and sequestrum was not present two holes were made, one at each end of the bone, through separate incisions, by the help of bone awl or bone dril. Through these holes irrigation tubes were placed inside the marrow cavity.
- Irrigation and suction tubes were placed parellel side-by-side and exiting in opposite direction.
- The tubes were brought out obliquely from the wound through as much soft tissue as possible, penetrating the skin with the trochar atleast 1 inch away from the incision line. One point was kept in mind while placing the tube that perforated part of the tube must not be in the muscle plane and extra part of the perforated tube was cut.
- Tubes were fixed externally with the skin tightly so that tubes must be secure to the skin up to desired period.

- Wound was closed in layers and properly dressed.
- Post-operative immobilisation was given either in form of plaster of paris slab or in form of skin traction over Thomas' splint according to the bone involved.
- Irrigation tube was connected to the irrigation bottle containing normal saline and one or two antibiotics.
- Suction tube was connected to the suction apparatus.
- Irrigation-suction machanism started and its functioning checked.

Irrigation Fluid

Normal saline was used for the purpose of irrigation.

SELECTION OF ANTIBIOTICS

- One or two antibiotics were mixed in the normal saline according to culture and sensitivity report.
- When culture and sensitivity can not be possible or sterile then crystalline penicilline and Gentamicin were used till report obtained.
- When pus found to be resistant to all antibiotic then also crystalline penicilline and Gentamicin were used.
- During pre-operative and post-operative periods systemic antibiotics were also given.
- Dilution of antibiotics in normal saline was :

Crystalline penicilline	: 10 Lac IU/Lit.
Streptomycin	: 2 gm/Lit.
Gentamicin	: 80 mg/540 ml.

Chloramphenicol : 1 gm/Lit.

Ampicillin : 1 gm/Lit.

Cephazoline : 1 gm/Lit.

- The outcoming fluid was cultured regularly and antibiotics were changed according to the sensitivity report.

MAINTENANCE OF CONTINUOUS IRRIGATION-SUCTION TECHNIQUE

- For the first two days 2000-2500 ml of irrigation fluid per day was used. This is because the problem of blockage in suction tube is maximum during first two days and by keeping the irrigation flow fast this problem was solved.
- Problem of blockage in the tube was solved by reversing the flow of tubes.
- From the third day onward 1000-1500 ml irrigation fluid was used per day.

DURATION OF CONTINUOUS IRRIGATION-SUCTION TECHNIQUE

- Outcoming fluid was cultured at regular intervals and irrigation was continued till two consecutive cultures of out coming fluid were sterile.
- This technique was usually continued for 2-3 weeks.
- First, irrigation tube was taken out and suction was continued till fluid came out and then suction tube was also removed.

IRRIGATION-SUCTION APPARATUS

- For irrigation normal saline bottles containing 540 ml normal saline were used and appropriate amount of antibiotics was added.
- With the help of I-V infusion set this bottle was connected to irrigation tube.
- Irrigation-suction tubes : Gamma irradiated sterilised P.V.C. tubes of F.G.-10 size were used. These tubes were reasonably stiff because soft tube might colapse under negative pressure. These tubes were having multiple side holes at proximal end.
- Suction apparatus - Three types of suction apparatus were used :

1. Glass bottle with PVC tubings - negative pressure was generated in the bottle by the help of suction machine and this bottle was connected to suction tube. Outcoming fluid was collected in this bottle.
2. Plastic bag with PVC connections - negative pressure was generated inside the bag by compressing it and this device was attached to suction tube and outcoming fluid was collected in the bag.
3. 3. Electrical slow suction apparatus - Suction tube was attached to this apparatus. Advantage of this apparatus is that suction pressure can be regulated according to the requirements.

- Stitches were removed after 12-14 days depending upon the condition of local area.
- Check skiagrams were taken with the tubes in position to assess the success of operation or any left over piece of sequestrum.
- Later on patients were discharged with the immobilisation according to site and extent of involvement and with instructions to continue the prescribed antibiotics in appropriate doses for further four to six weeks.

FOLLOW UP

All the cases were advised to report to this hospital periodically and were assessed clinically for pain, tenderness, discharge, soft tissue healing or any other complications and radiologically to see the condition of bone whether radiologically there is any persisting evidence of infection(e.g. sequestrum formation).

Type of secondary treatment if given in any case of recurrence or having complications was also noted.

Different workers have laid down different criteria for assessment of results of continuous irrigation and suction technique. But none of the previous workers have laid down the clear cut criteria for the assessment of result. E. Michelinakis (1972)

used following criteria for good result. (a) Duration of clinically symptom free periods and (b) no radiological evidence of infection.

Clawsen et al (1973) considered the results by following 3 parameters : Discharge, pain and toxicity.

In this series definite clinical and radiological criteria were used for the assessment of the results in three grades i.e. Excellent, good and poor.

A. Clinical Criteria

i. Healing by primary or secondary intension.

ii. Sinus.

iii. Residual infection.

iv. Pain.

v. Tenderness.

vi. Discharge.

B. Radiological Criteria

i. Evidence of infection.

ii. Sequestrum formation.

GRADES

Excellent

When there was healing by primary intention no sinus or residual infection, no pain or local tenderness no radiological evidence of infection.

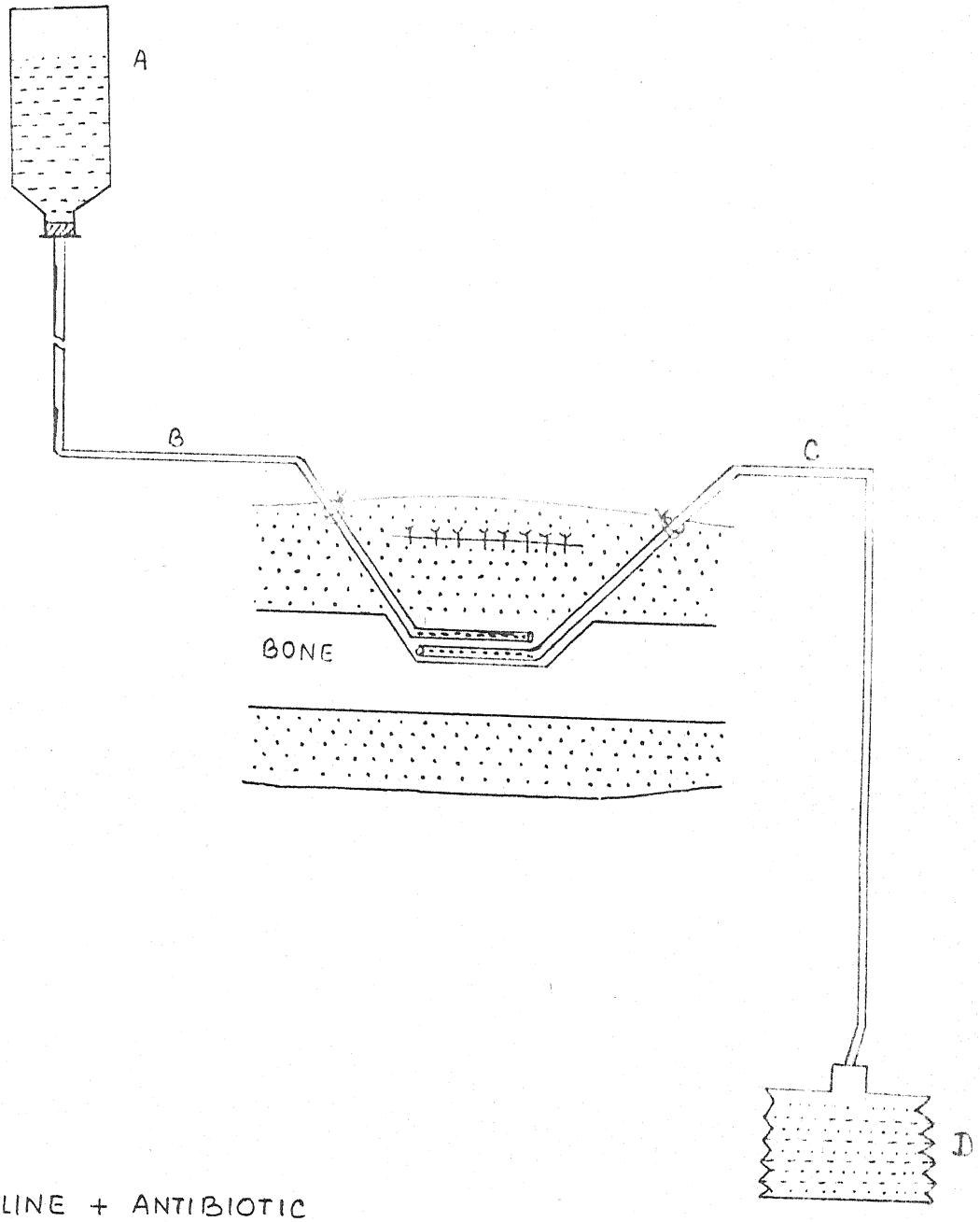
Good

When there was delayed wound healing or occasional pain and tenderness but no discharge or sinus and no radiological evidence of infection.

Poor

When there was persistant pain or discharge or radiological evidence of infection or formation of sequestrum.

All the above information regarding clinical examination, investigations, operative procedures and follow up findings were noted down in a proforma. The sample of which is attached in appendix.



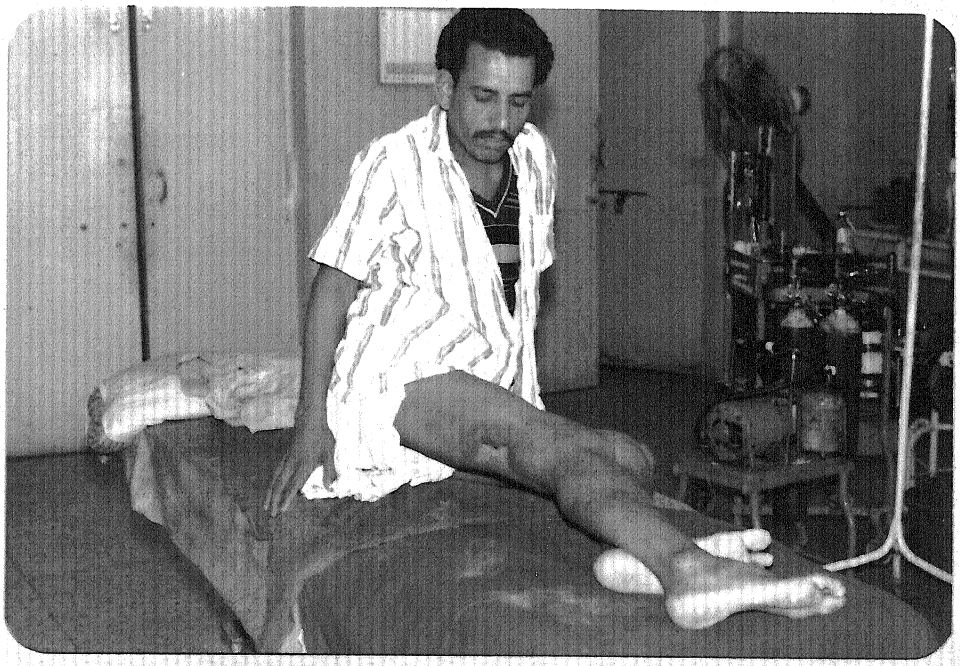
A : N. SALINE + ANTIBIOTIC

B : IRRIGATION - TUBE

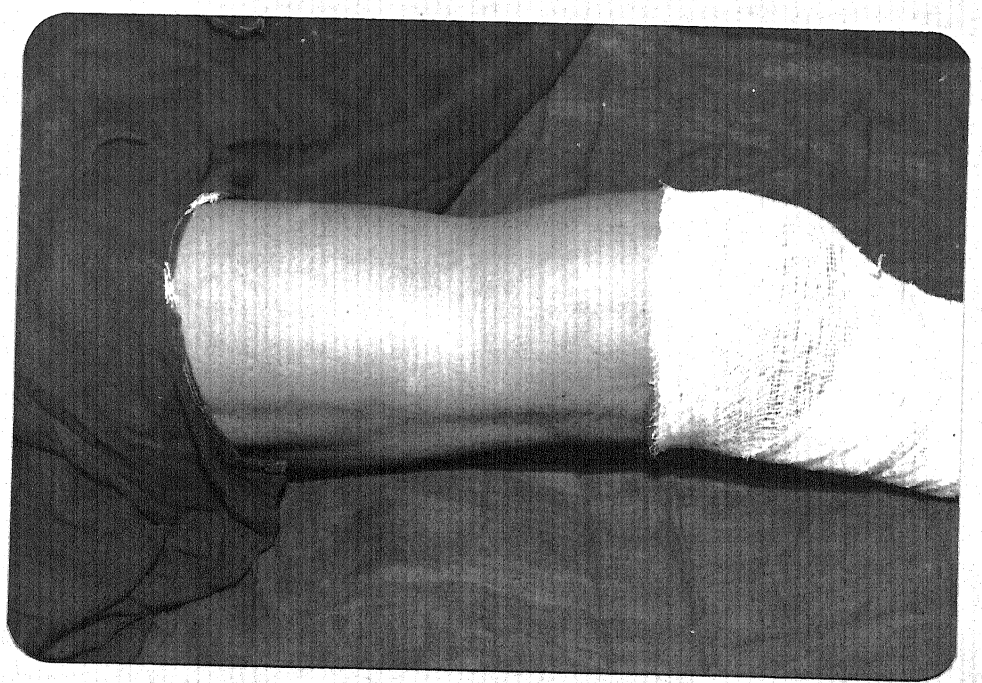
C : SUCTION - TUBE

D : SUCTION - APPARATUS.

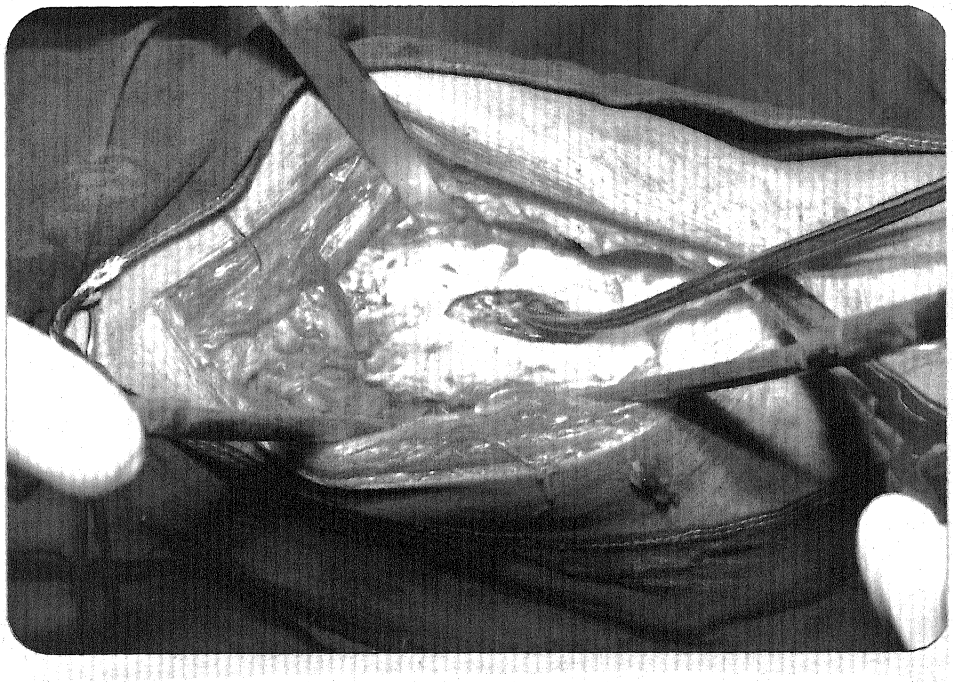
DIAGRAM SHOWING IRRIGATION - SUCTION SYSTEM.



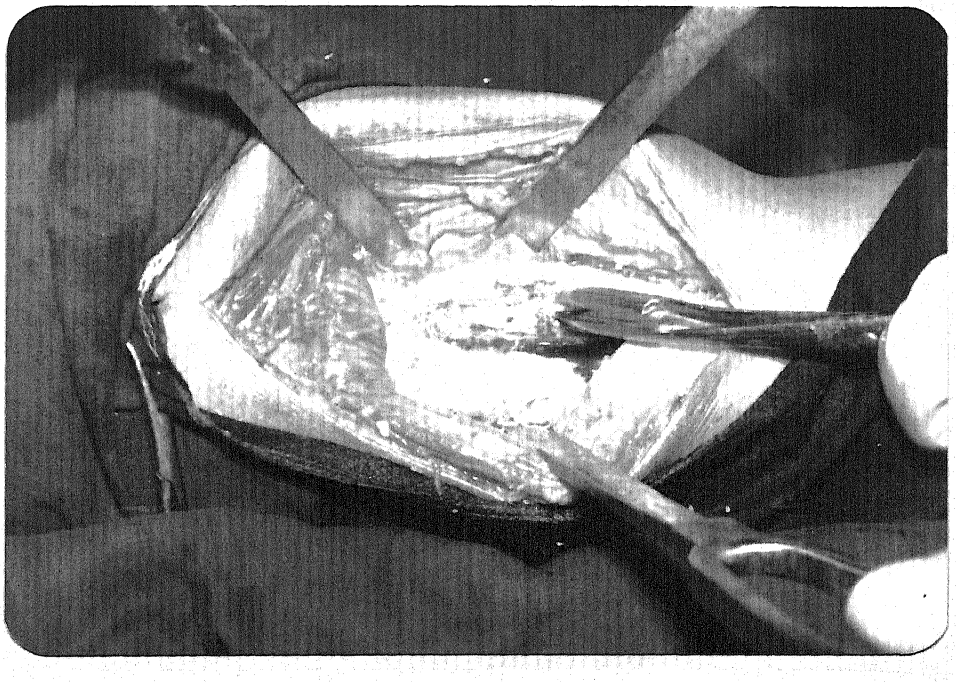
Ph. No. 1 : Showing sinus on posterior aspect of thigh.



Ph. No. 2 : Thigh with part painted and draped.

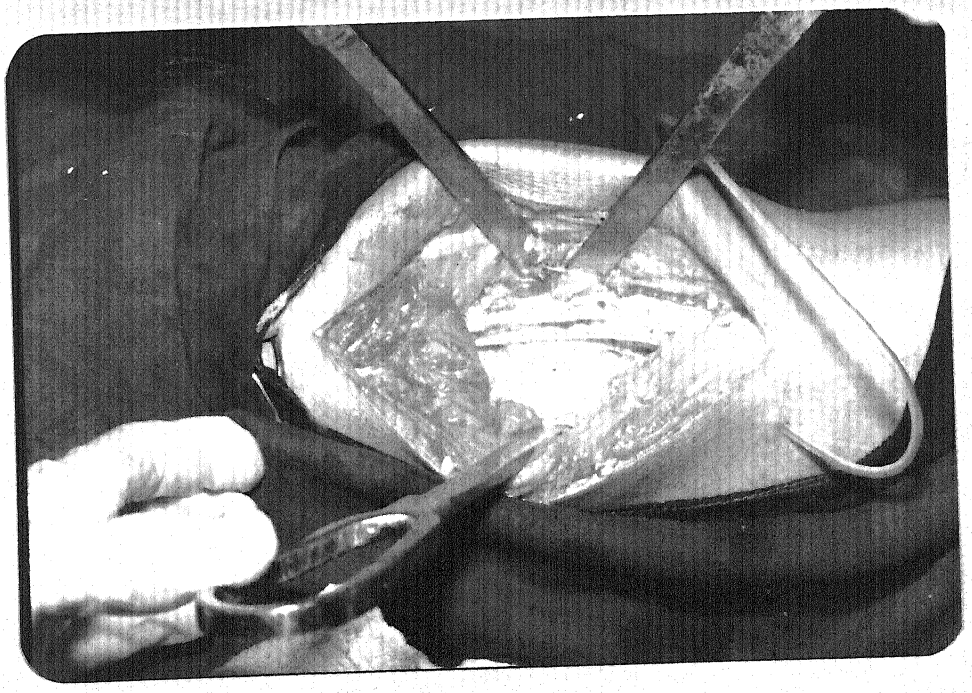


Ph. No. 3 : Showing sequestrum through the pre-existing window in the femur.

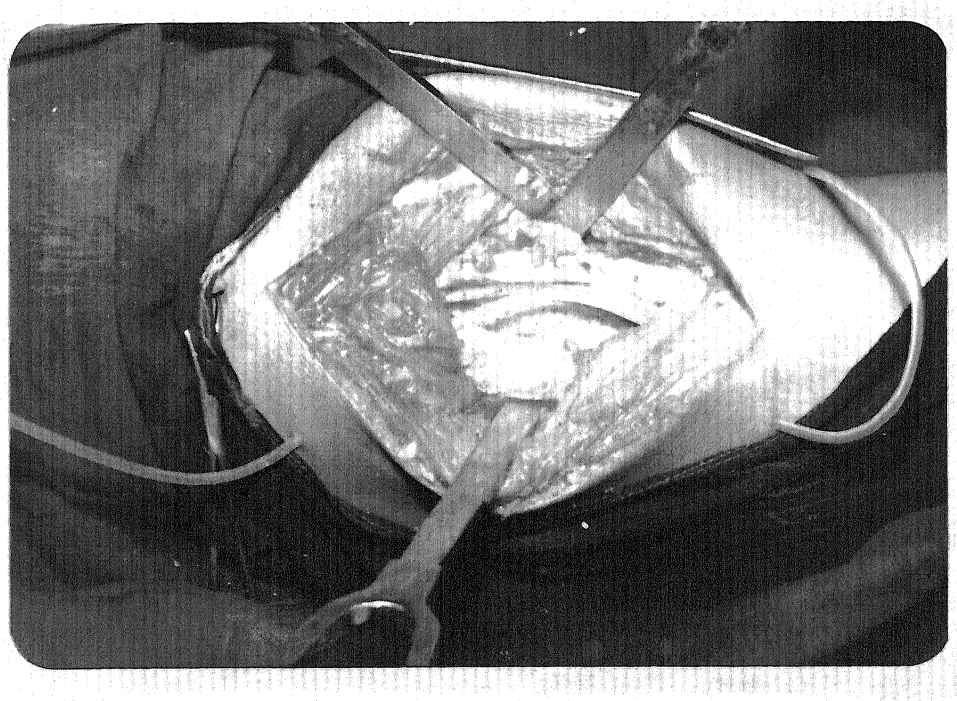


Ph. No. 4 : Sequestrum was being taken out after increasing the window size.

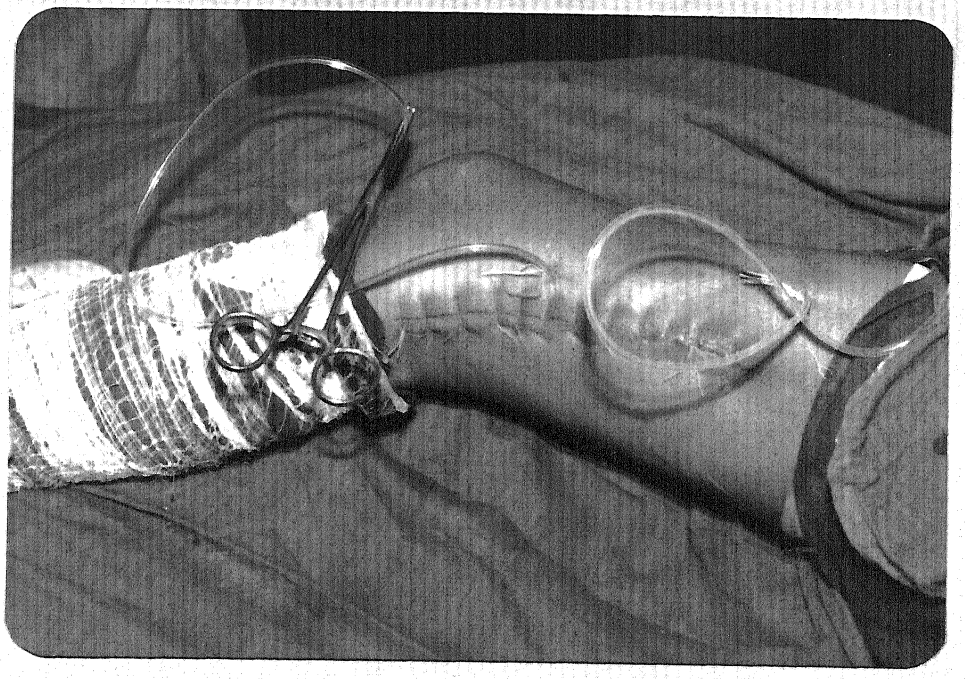
Ph. No. 5 : Saucerized femur along with sequestrum.



Ph. No. 6 : Ingoing irrigation tube inside saucerized cavity.

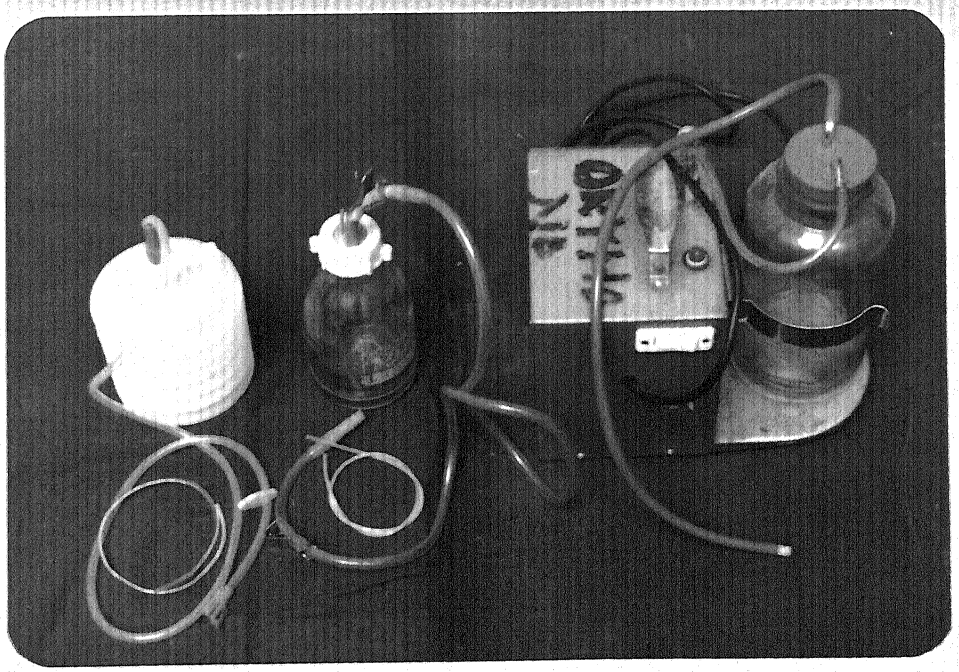


Ph. No. 7 : Outcoming suction tube inside saucerized cavity.



Ph. No. 8 : Showing stitch line and anchored tubes.

Ph. No. 9 : Showing irrigation-suction mechanism in functioning.



Ph. No. 10 : Showing all 3 types of suction apparatus along with irrigation and suction tubes (From Lt to Rt App. No. 2,1, 3).

OBSERVATIONS

OBSERVATION

The present study "To evaluate the effect of continuous irrigation-suction technique by using antibiotic solution in the treatment of chronic osteomyelitis" was carried out on 24 patients of proved chronic osteomyelitis of different bones, admitted in orthopaedic ward, of M.L.B. Medical College, Hospital, Jhansi between July, 1987 and June, 1988. Patients were treated by continuous irrigation and suction technique by using antibiotic solution. Out of 24 patients 1 patient died post-operatively due to flaring up of septicemia and bacterimia.

Out of 24 patients mode of spread haematogenous in 21 cases (87.50%) and in rest 3 (12.50%) nonhaematogenous osteomyelitis was found (Table I).

Table I : Mode of spread of osteomyelitis.

Spread of osteomyelitis	No.of cases	Percentage
Haematogenous	21	87.50
Non-haematogenous		
a. In simple fracture	3	12.50
b. In compound fracture	-	-
Total	24	100.00

The patients of present series were from different age groups ranging from 7 years to 50 years. Mean age of the patients was 19.79 years. 54.17% patients were from

second decade of life followed by 16.67% and 12.50% patients from third and first decade respectively (Table II).

Table II : Incidence of age distribution of the cases.

Age group (years)	No. of cases	Percentage
0 - 10	3	13.50
11 - 20	13	54.17
21 - 30	4	16.67
31 - 40	2	8.33
41 - 50	2	8.33
750	-	-
Total	24	100.00

In this study, out of 24 cases, 21 (87.50%) cases were male and 3 (12.50%) cases were female. (Table III, Fig. 1).

Table III : Sex distribution of the cases.

Sex	No. of cases	Percentage
Male	21	87.50
Female	3	12.50
Total	24	100.00

According to the socio-economic status of patients, 12 (50.0%) cases were poor, 6(25.0%) cases were from lower middle class and rest 6(25.0%) cases were from middle class (Table IV).

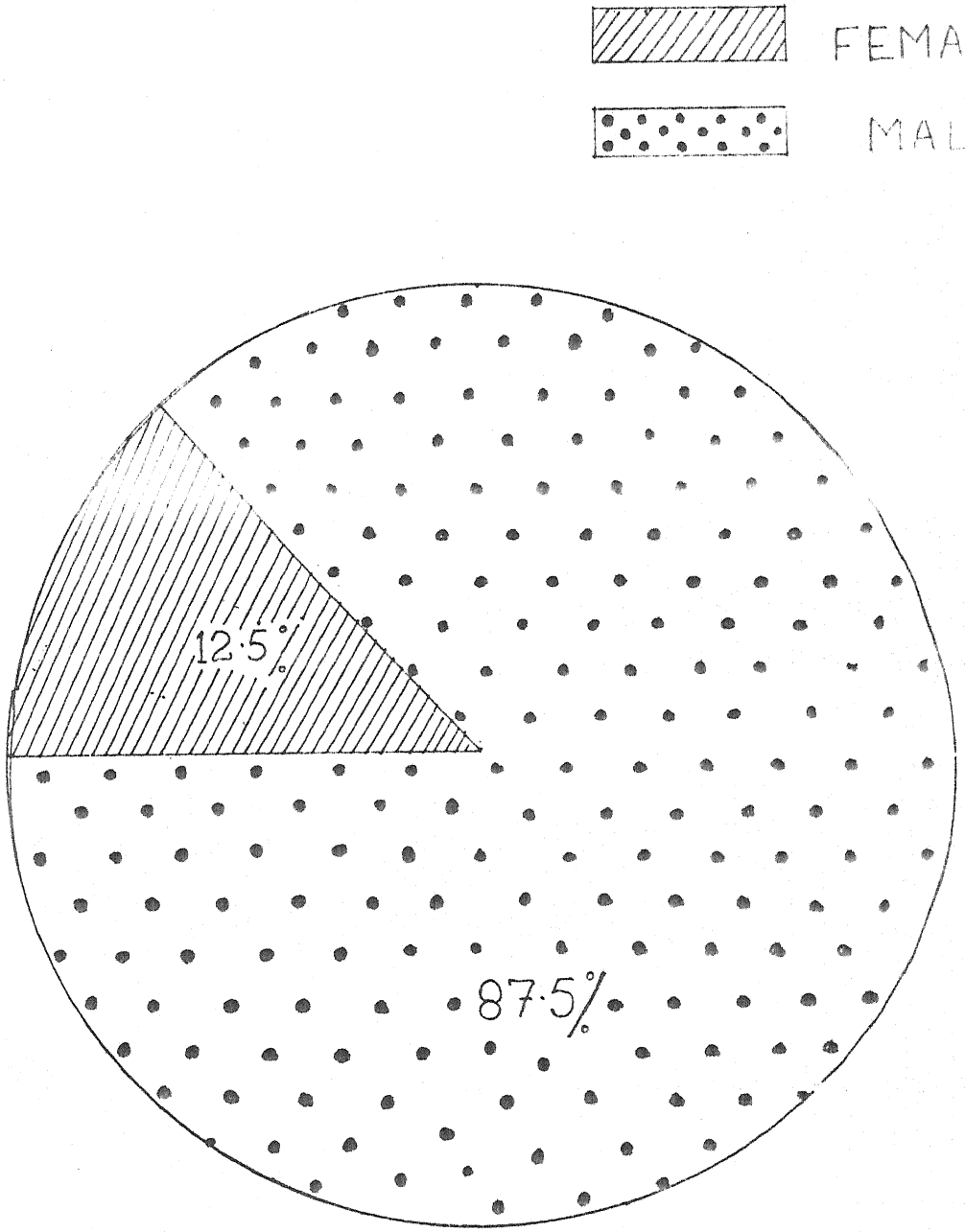


FIG. 1 SEX - DISTRIBUTION

Table IV : Incidence of socio-economic status of cases.

Socio-economic status	No.of cases	Percentage
Lower	12	50.00
Lower middle	6	25.00
Middle	6	25.00
High	-	-
Total	24	100.00

Following was the incidence of different bones involvement. Femur was involved in maximum number of cases (11, 45.83%) followed by tibia 6(25.0%) cases, humerus and radius 3 (12.50%) cases each, Ilium was involved in 1 (4.17%) case only (Table V).

Table V : Incidence of bone involvement in cases

Bone involvement	No. of cases	Percentage
Femur	11	45.83
Tibia	6	25.00
Humerus	3	12.50
Radius	3	12.50
Ilium	1	4.17
Total	24	100.00

Out of 24 cases, bones of lower extremities were involved in 18(75.0%) cases while bones of upper extremities were involved in 6 (25.0%) cases (Table VI).

Table VI : Incidence of limb involvement.

Limb	No. of cases	Percentage
Upper	6	25.00
Lower	18	75.00
Total	24	100.00

Duration of illness in cases of present study was quite variable ranging from 1½ months to 8 years. The average duration of involvement was 17.88 months. Nine cases (37.50%) were having duration of involvement from 0-6 months. Five cases (20.83%) each were having duration of involvement from 7-12 months and 13-18 months. One case (4.17%) was having duration of illness from 19-24 months while 4 (16.67%) cases were having illness of more than 24 months duration (Table VII).

Table VII : Incidence of duration of illness.

Duration (months)	No. of cases	Percentage
0 - 6	9	37.50
7 - 12	5	20.83
13 - 18	5	20.83
19 - 24	1	4.17
7 24	4	16.67
Total	24	100.00

Involvements of joints was detected by seeing movement arround neighbouring joints when movements found to be restricted then a joint is said to be involved. Joints were involved in 11 (45.83%) patients while rest 13(54.17%)

cases were not having joint involvement (Table VIII).

Table VIII : Incidence of joint involvement.

Joint involvement	No. of cases	Percentage
Present	11	45.83
Absent	13	54.17
Total	24	100.00

In present study 23 (95.83%) cases were having one or more discharging sinus while only 1 (4.17%) case was devoid of discharging sinus (Table IX).

Table IX : Incidence of existing sinuses.

Discharging sinuses	No. of cases	Percentage
Present	23	95.83
Absent	1	4.17
Total	24	100.00

Twelve cases (50%) were previously treated with chemotherapy while 17 (70.83%) cases had one or more incision and drainage procedure and in 5 (20.83%) cases saucerization and/or sequestrectomy was performed previously (Table X).

Table X : Showing previous treatment.

Type of previous treatment	No. of cases	Percentage
Chemotherapy	12	50.00
Incision and drainage	17	70.83
Saucerization and/or sequestrectomy	5	20.83

In 6(25.0%) cases of present series no surgical procedure was performed before coming to this hospital. In 11 (45.83%) cases single surgical procedure was performed previously while in 4(16.67%) patients 2 surgical procedures had taken place. Three , four and more than four procedures were performed in 1 (4.17%) case each (Table XI).

Table XI : Number of previous surgical procedure.

No. of surgical Procedure	No. of cases	Percentage
0	6	25.00
1	11	45.83
2	4	16.67
3	1	4.17
4	1	4.17
7+	1	4.17
Total	24	100.00

Pus culture of pre-operative samples shows following microbiology. Staphylococcus aureus was the commonest organism isolated from 10(41.65%) cases while from 1 (4.17%) case it was isolated along with proteus. Pseudomonas was isolated from 3 (12.50%) cases whereas E.Coli, Klebsiella and Proteus were isolated from 1(4.17%) cases each. E. Coli along with proteus was isolated from one (4.17%). No organism was isolated from 6(25.0%) cases i.e. their cultures were sterile (Table XII).

Table XII : Incidence of various organisms isolated from patients pre-operatively.

Organisms	No.of cases	Percentage
Staph. aureus	10	41.65
Staph. aureus + Proteus	1	4.17
Pseudomonas	3	12.50
Klebsiella	1	4.17
E. Coli	1	4.17
Proteus	1	4.17
E. Coli + Proteus	1	4.17
Sterile	6	25.00
Total	24	100.00

Incidence of super infection was detected by culture of drainage fluid. If organisms cultured were other than the pre-operative organisms then it mean that super infection had taken place. Eight cases (33.33%) showed super infection while in 16(66.67%) cases there was no superinfection.

Pseudomonas was the commonest organism responsible for super infection isolated in 4(16.67%) cases (Preoperative organism was Staph. aureus in 3 cases while in 1 case no organism was isolated).

In 2 (8.33%) cases Proteus was the organism (Pre-operative organism was Staph. aureus in 1 case and Klebsiella in other one). while in 1 (4.17%) case Staph. aureus was responsible for super infection (No organism was isolated pre-operatively). In 1 (4.17%) case mixed super

infection had occurred where . Coli along with Proteus was isolated from drainage fluid (Pre-operative organism was Staph. aureus) (Table XIII, Fig. 2).

Table XIII : Incidence of bacterial super-infection in drainage fluid.

Super infecting organism	No.of cases	Percentage
Pseudomonas (Pre-Op. Staph. aureus - 3, Sterile - 1)	4	16.67
Proteus (Pre-op. Staph. aureus - 1, Klebsiella - 1)	2	8.32
Staph. aureus (Pre-op. Sterile - 1)	1	4.17
E. Coli + Proteus (Pre-op. Staph. aureus - 1)	1	4.17
Total incidence of superinfection	8	33.33
No super infection	16	66.67
Total	24	100.00

Radiological features present in patients of this study were as follows. Periosteal reaction was present in 23 cases. Sequestrum was seen in 14 cases. Bone destruction was visualized in 21 cases. Sclerosis was evident in 13 cases. Thickening of the bone was noticed in 16 cases while cavity was identified in 17 cases (Table XIV, Fig. 3).

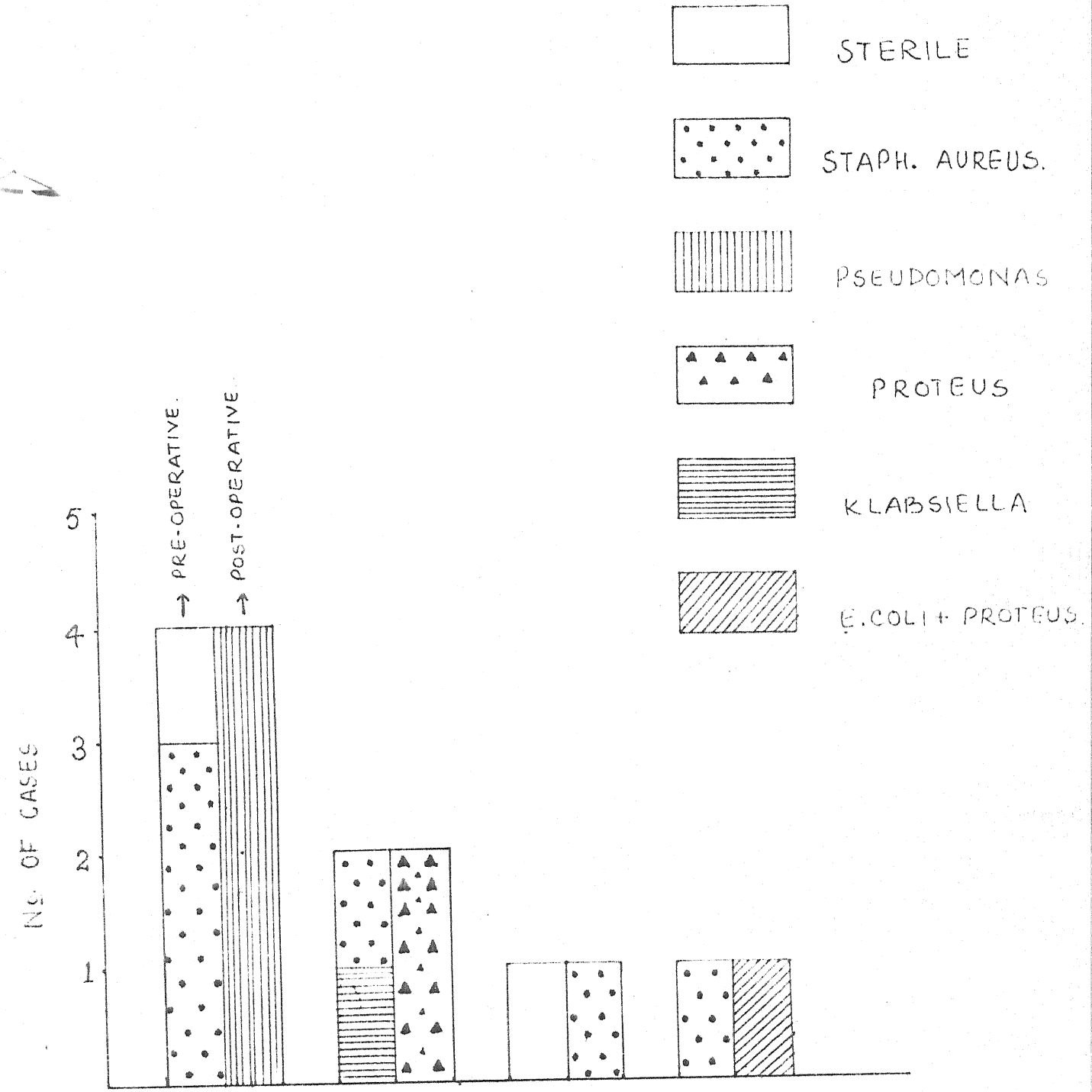


FIG:2-INCIDENCE OF BACTERIAL-SUPERINFECTION

Table XIV : Showing radiological features.

Radiological features	No. of cases
Periosteal reaction	23
Sequestrum	14
Destruction	21
Sclerosis	13
Thickening	16
Cavity	17

Various types of operation were performed in different patients along with the use of continuous irrigation and suction technique. Curettage was done in 9 cases, syringectomy was performed in 14 cases and in 2 cases drill holes were made at the ends of bones. Saucerization was performed in 18 cases while sequestrectomy was done in 13 cases (Table XV).

Table XV : Showing the types of operation done.

Types of procedure	No. of cases
Curettage	9
Syringectomy	14
Drill hole at the ends of bone	2
Saucerization	18
Sequestrectomy	13

In the present series healing occurred by primary and secondary intention in 16 (69.56%) and 7(30.44%) cases respectively (Table XVI).

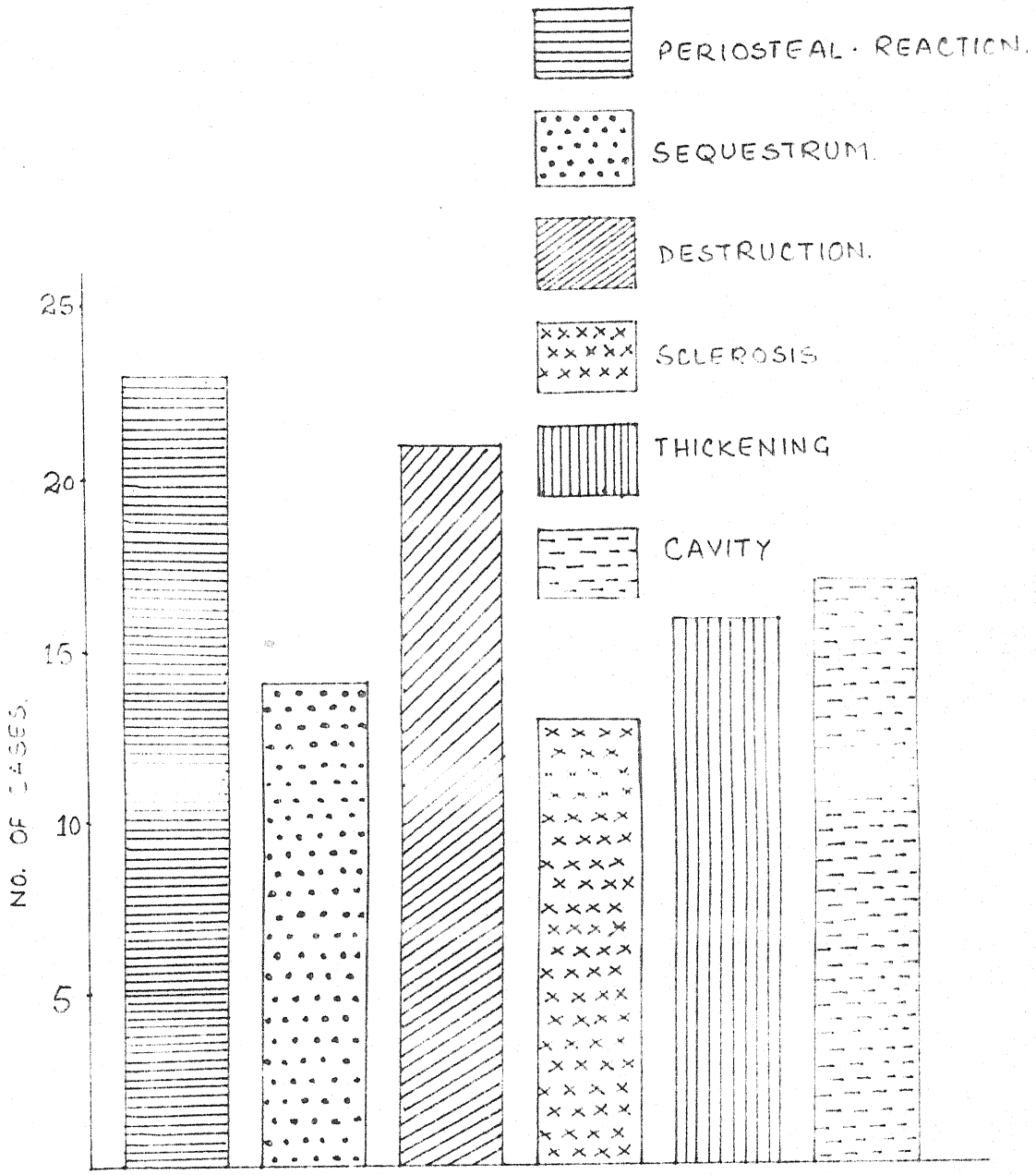


FIG. 3 RADIOLOGICAL - FEATURES.

Table XVI : Showing type of wound healing.

Type of wound healing	No.of cases	Percentage
Primary intention	16	69.56
Secondary intention	7	30.44
Total	23	100.00

Post-operative hospital stay of the patients ranged from 14 to 40 days with the average stay of 22.26 days. Fourteen (60.87%) cases remained in the hospital from 0-3 weeks postoperatively. Seven cases (30.44%) had post-operative hospital stay from 3-4 weeks while 2(8.70%) patients had more than 4 weeks stay (Table XVII).

Table XVII : Duration of post-operative hospital stay.

Duration (weeks)	No. of cases	Percentage
0 - 3	14	60.87
3 - 4	7	30.43
7 4	2	8.70
Total	23	100.00

The complications were divided into early and late. Early complications included gaping of stitch line in 6 cases (without exposure of bone). There was persistent discharge after operation in 4 cases while in 1 patient bone was exposed after the gaping of stitch line. One patient expired due to flaring up of septicemia and bacterimia post operatively. Sequestra formation and recurrence of infection was seen in one case. One patient had pathological fracture after 2 months of surgery(Table XVIII).

Table XVIII : Showing various complications.

Complications	No. of cases
A. EARLY	
Sloughing of skin with exposure of bone	1
Gaping of stitch line (without exposure of bone)	6
Persistant discharge after operation	4
Neurovascular	-
B. LATE	
Recurrence of infection	1
Sequestrum formation	1
Pathological fracture	1

Note : One patient was expired due to post-operative flaring up on septicemia and bacterimia.

The most frequent problem faced in initial cases was the blockage of suction tube. This problem was maximum in first two days after the surgery. This problem was solved in later cases by keeping the irrigation flow fast for first 2 days and by reversing the irrigation flow. However, this problem was faced in as many as 5 cases. None of the case required discontinuation of irrigation suction technique. Leaking was seen in 4 cases. In one case we had to discontinue the suction irrigation due to gapping of stitch line and exposure of bone.

The problem of swelling of the limb due to collection of irrigation fluid was secondary to the plugging of suction tube. This problem was faced in 5 cases where there was blocking of suction tube.

In 1 case the tube was pulled out during 1st post operative day and was reinserted after reopening the wound in operation theatre (Table XIXA).

Table XIXA : Untoward incidence of suction-irrigation technique.

Untoward incidence	No.of cases	Irrigation discontinued
Leaking	4	1
Plugging of tube	5	-
Swelling	5	-
Tube pulled out	1	-

In 16 (69.56%) cases there was no significant problem during the period of irrigation and suction while in 7 (30.44%) cases one or more problems were faced shown in table XIXB.

Table XIXB :

Problem in irrigation suction technique	No.of cases	Percentage
Present	7	30.44
Absent	16	69.56
Total	23	100.00

Duration of irrigation-suction technique ranged from 6-21 days with the average of 13.17 days. Irrigation technique was continued for 6-10 days in 6(26.09%) cases. In 11(47.81%) cases it was continued for 11-15 days and in 5(21.74%) cases for 16-20 days while in one case(4.36%) it was continued for more than 20 days(Table XX, Fig. 4).

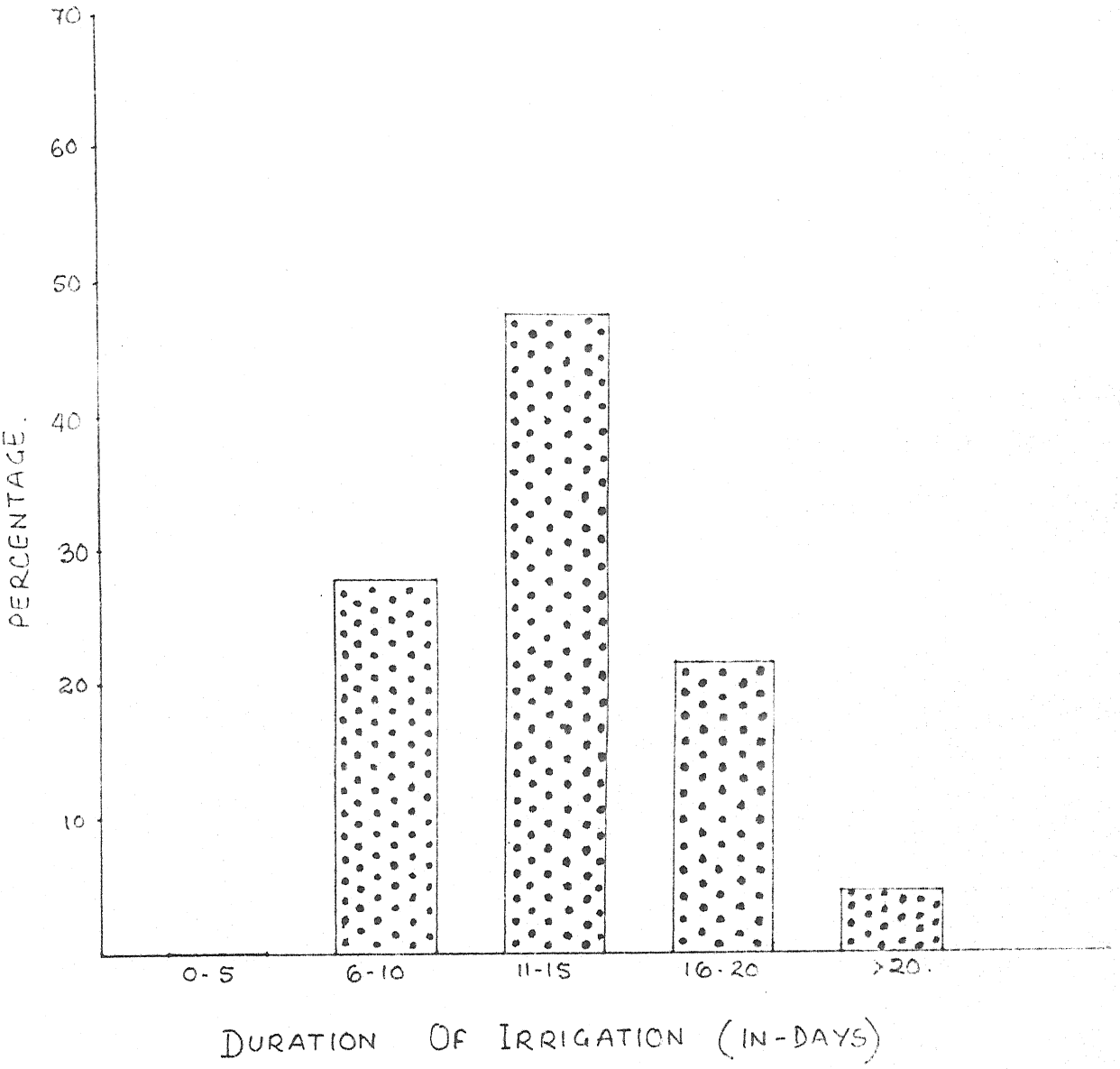


FIG.-4. DURATION OF IRRIGATION.

Table XX : Duration of irrigation.

Duration of irrigation	No. of cases	Percentage
Days		
0 - 5	-	-
6 - 10	6	26.09
11 - 15	11	47.81
16 - 20	5	21.74
7 20	1	4.36
Total	23	100.00

Total normal saline used for single patient for irrigation ranged 8.4 lit to 27.3 lit with the average of 17.7 lit. In 2(8.70%) cases 5-10 lit normal saline was used. and in 5(21.74%) 10-15 lit. saline was used in each case. In 7(30.42%) cases 15-20 lit. saline was used. 20-25 lit. saline was used in 8(34.78%) cases while 7 25 lit. saline was used in one patient(4.36%) (Table XXI).

Table XXI : Total amount of saline used for irrigation.

Amount (Lit.)	No.of cases	Percentage
5- 10	2	8.70
10 - 15	5	21.74
15 - 20	7	30.42
20 - 25	8	34.78
7 25	1	4.36
Total	23	100.00

Amount of the normal saline used for irrigation in different cases ranged from 1120 ml to 1600 ml per day

with the average of 1367.8 ml per day. In 2(8.70%) cases 1100-1200 ml saline per day was used. 1200-1300 ml saline per day was used in 6(26.09%) cases. 1300-1400 ml saline per day was used in 10(43.48%) cases for irrigation while in 5 cases more than 1400 ml saline was used per day for the purpose of irrigation (Table XXII).

Table XXII : Average amount of saline used for irrigation per day.

Amount of saline (ml)	No. of cases	Percentage
1100 - 1200	2	8.70
1200 - 1300	6	26.09
1300 - 1400	10	43.48
7 1400	5	21.73
Total	23	100.00

Out of all 303 days, 257(84.82%) days combination of crystalline penicillin and Gentamicin was used followed by the combination of Streptomycin and cephazoline for 21(6.93%) days while combination of ampicilline and Gentamicin was used for 14(4.62%) days and for 11(3.63%) days the combination of Crystalline penicillin and chloromphenicol was used.

Crystalline penicillin and Gentamicin combination was used in 21 cases followed by Crystalline penicillin and chloromphenicol combination in 3 cases. In 2 cases the combination of ampicilline and Gentamicin was used

and the combination of Streptomycin and cephasoline was used in 1 case (Table XXIII, Fig. 5).

Table XXIII : Antibiotic used for irrigation.

Antibiotics used	No.of cases	No.of days	Percentage
Crystalline penicillin + Gentamicin	21	257	84.82
Ampicillin + Gentamicin	2	14	4.62
Crystalline Penicillin + Chloromphenicol	3	11	3.63
Streptomycin + Cephasoline	1	21	6.63
Total		303	100.00

The change of the antibiotics was required for irrigation in 4 (17.39%) cases while in 19(82.61%) cases it was not required (Table XXIV).

Table XXIV : Change of antibiotic during irrigation.

	No.of cases	Percentage
Antibiotic changed	4	17.39
Antibiotic not changed	19	82.61
Total	23	100.00

Duration of follow up

Duration of follow up of the patients was ranged from 4 to 11.5 months with the average of 6.76 months. Twelve cases (52.17%) were followed up for the period of 3-6 months. For 6(26.09%) cases it was 6-9 months while for 5(21.74%) patients it was 9-12 months (Table XXV).

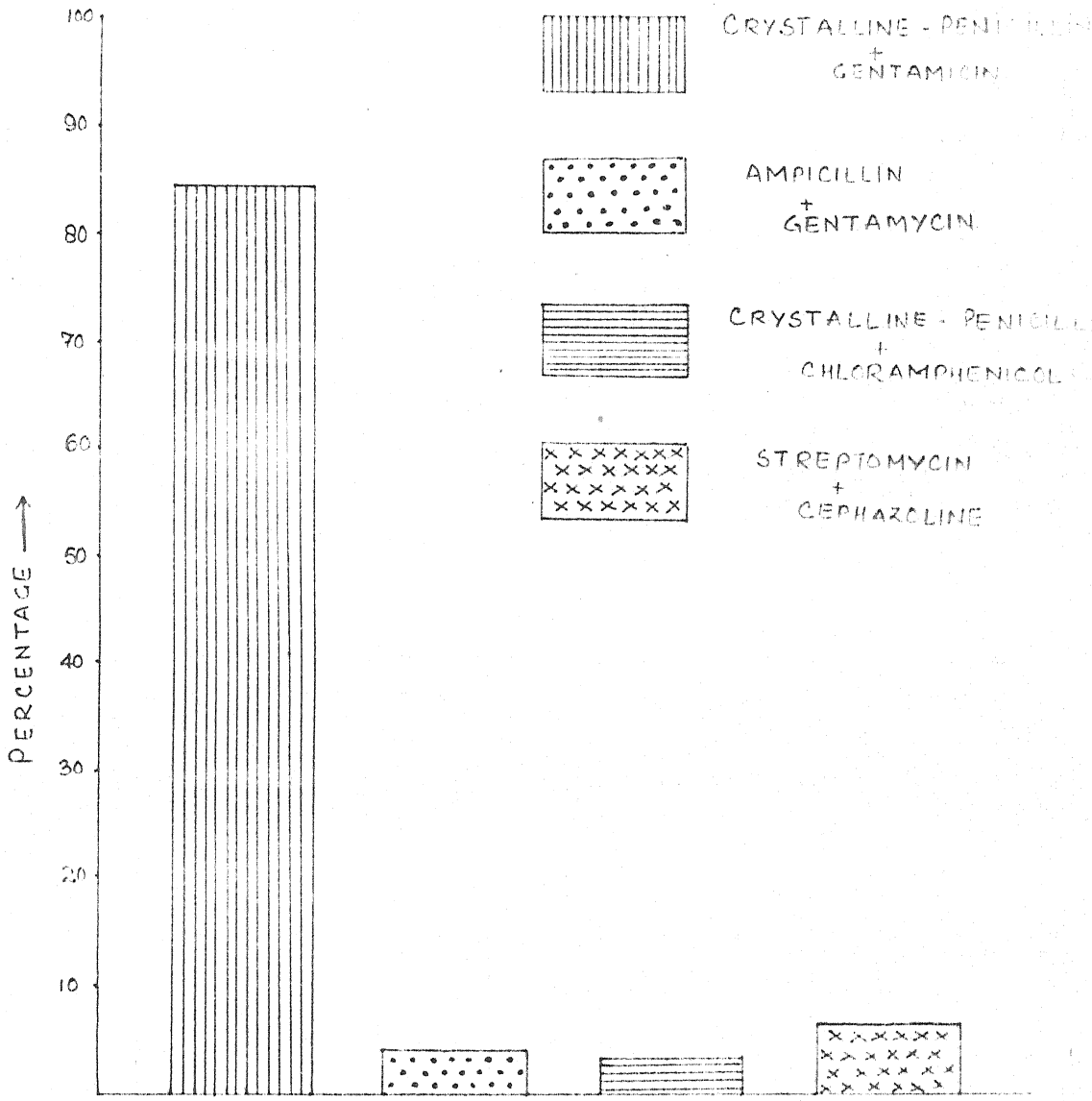


FIG: 5 ANTIBIOTICS USED FOR IRRIGATION.

Table XXV : Duration of follow up.

Duration (months)	No.of cases	Percentage
0 - 3	-	-
3 - 6	12	52.17
6 - 9	6	26.09
9 - 12	5	21.74
Total	23	100.00

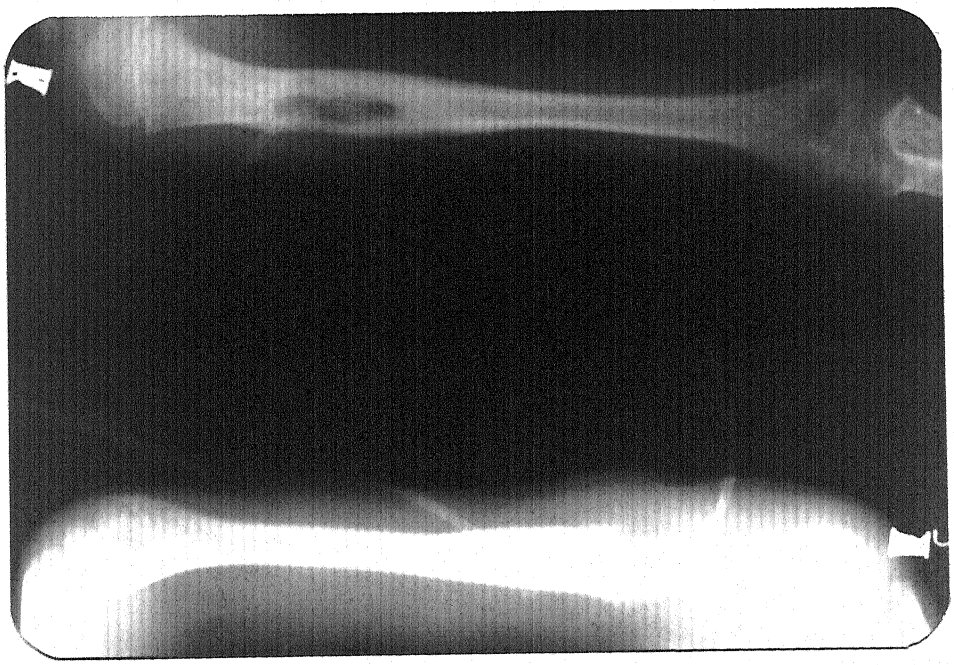
The result was excellent in 14 (60.87%) cases while good in 5(21.74%) cases. However results were poor in 4 (17.39%) cases (Table XXVI).

Table XXVI : Showing results.

Result	No.of cases	Percentage
Excellent	14	60.87
Good	5	21.74
Poor	4	17.39
Total	23	100.00

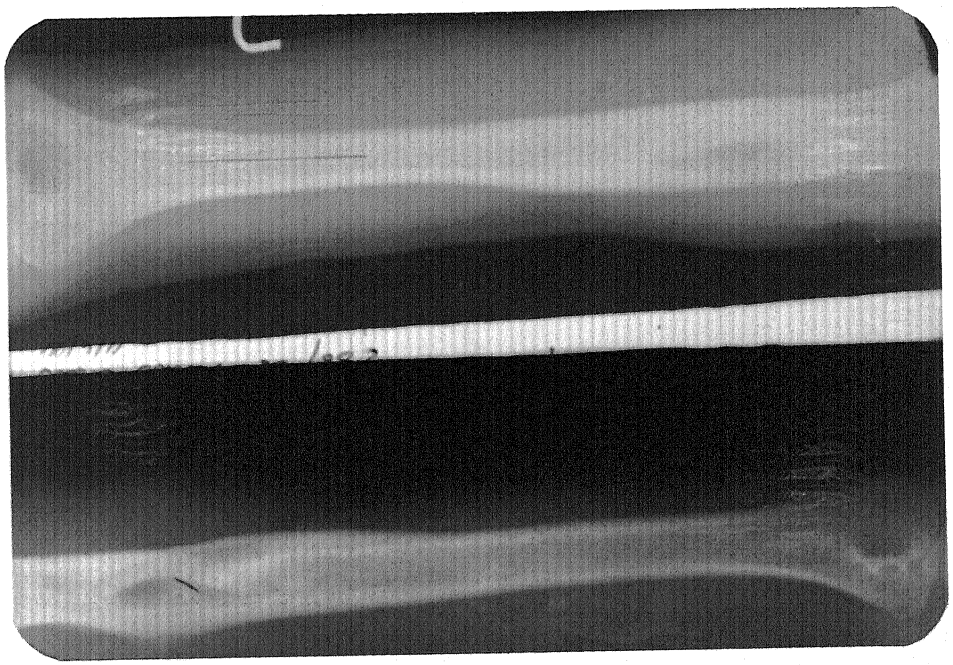
Patient No. 1

1. Pre-op. A.P. and Lat. Skiagram of Lt arm showing sequestrum inside the cavity with subperiosteal new bone formation of Humerus.

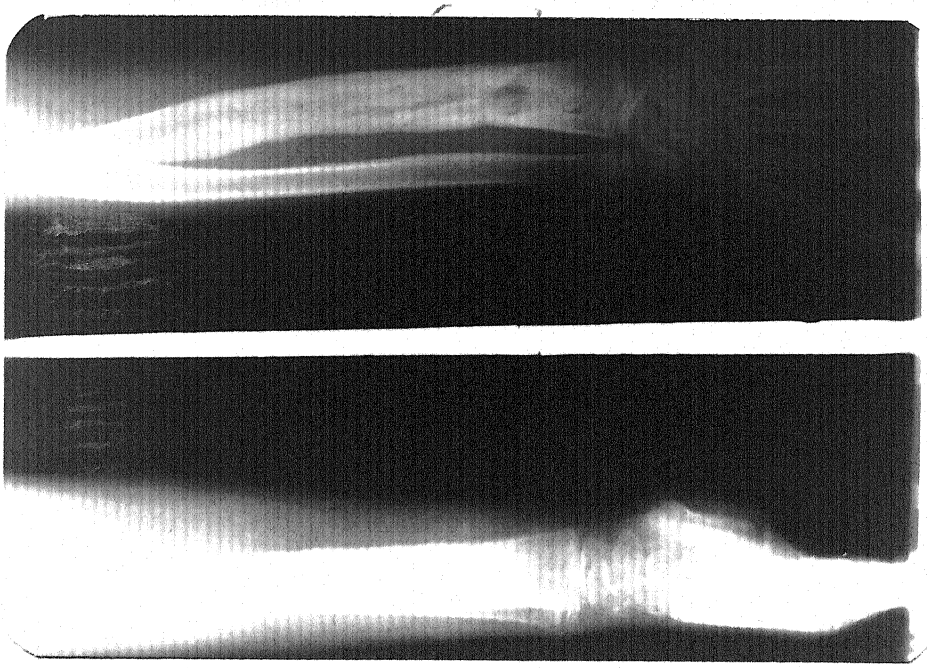


2. Post-Op A.P. and Lat. Skiagram of Lt arm showing saucerised cavity in humerus with both irrigation and suction tubes in place.

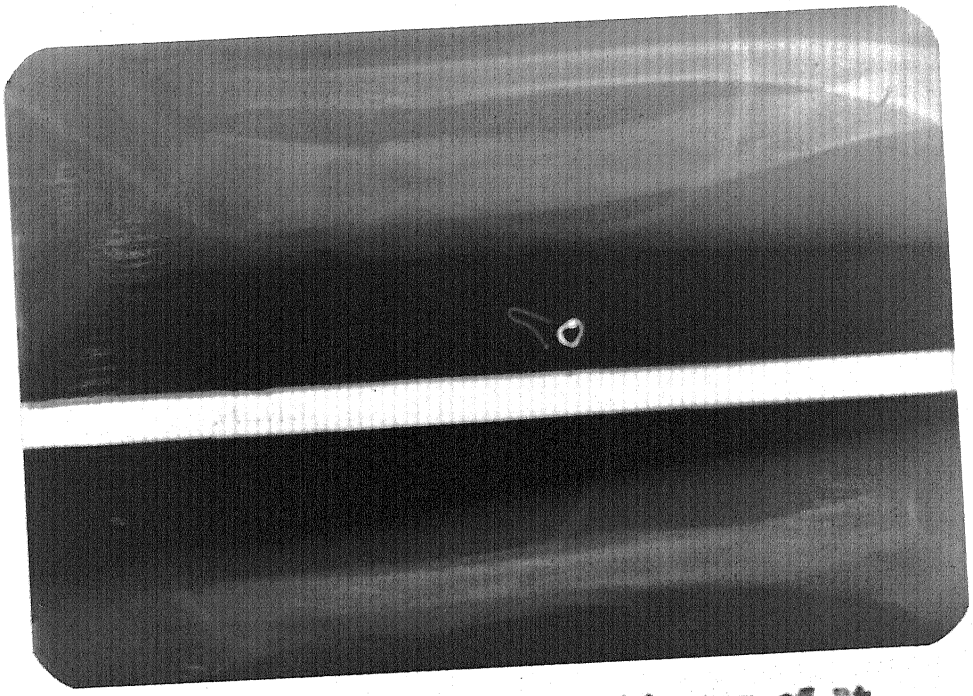
3. Follow-up A.P. and Lat. skiagram of Lt arm showing obliteration of cavity with marrow cavity patient on both sides (Taken 3 months after operation).



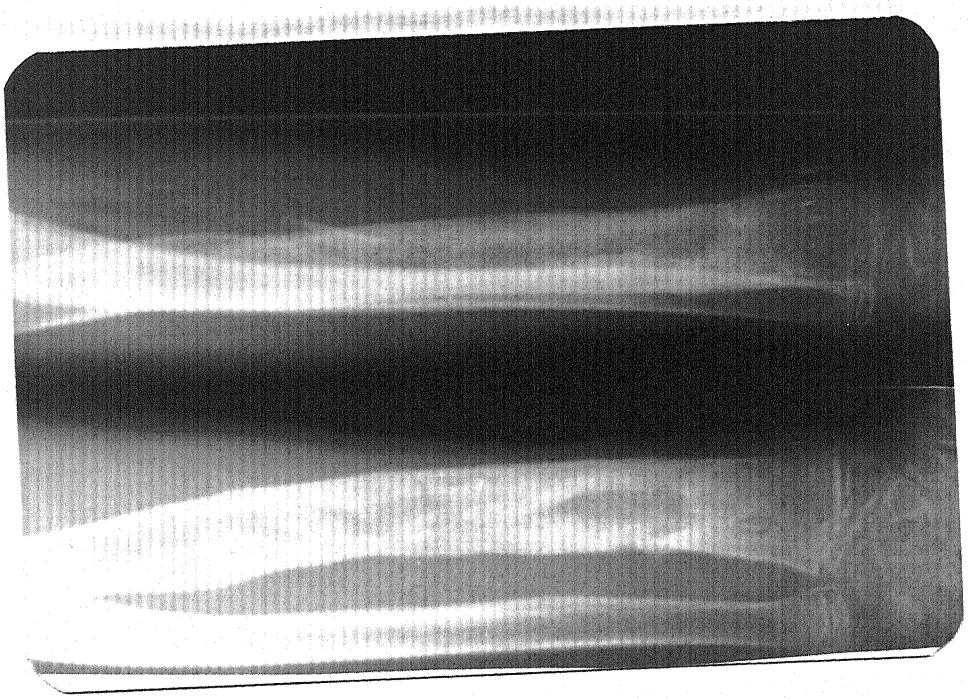
Patient No. 2



1. Pre-op. A.P. and Lat. skiagram of Rt forearm showing sequestrum inside the cavity with subperiosteal new bone formation in Radius.

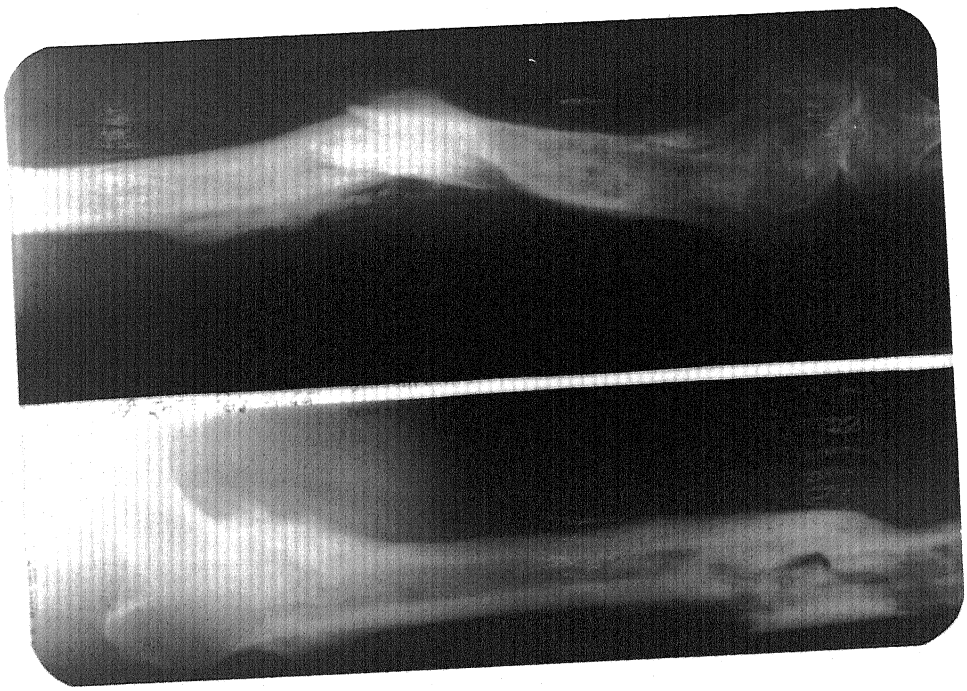


2. Post-op. A.P. and Lat. skiagram of Rt forearm showing saucerized cavity with both irrigation and suction tubes in position.

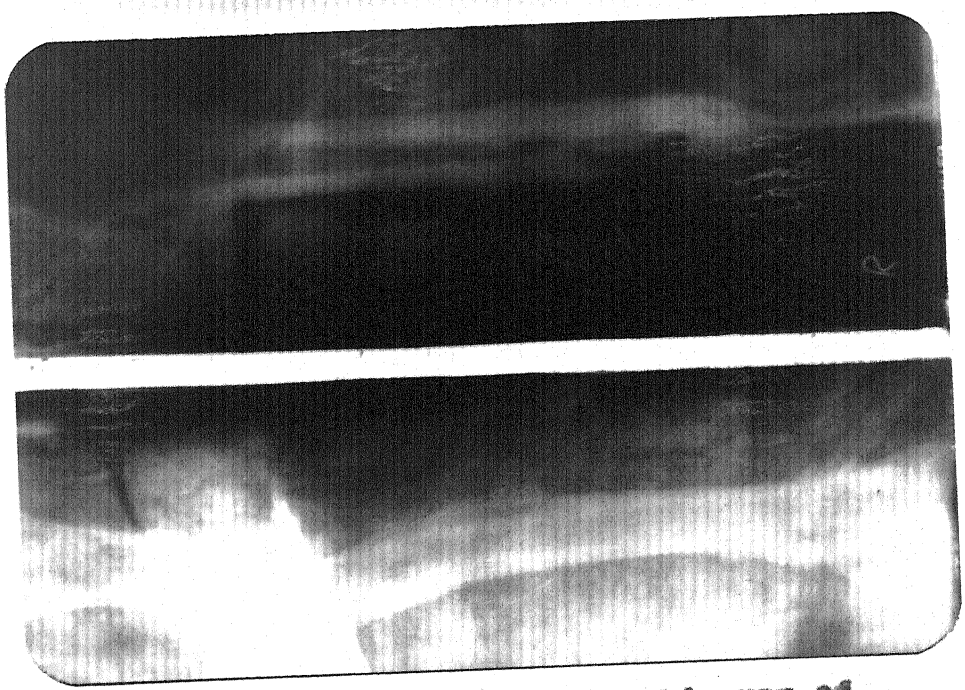


3. Follow up A.P. and Lat. skiagram of Rt forearm showing no evidence of residual infection with reduction in cavity size.(taken 4 months after operation).

Patient No. 3

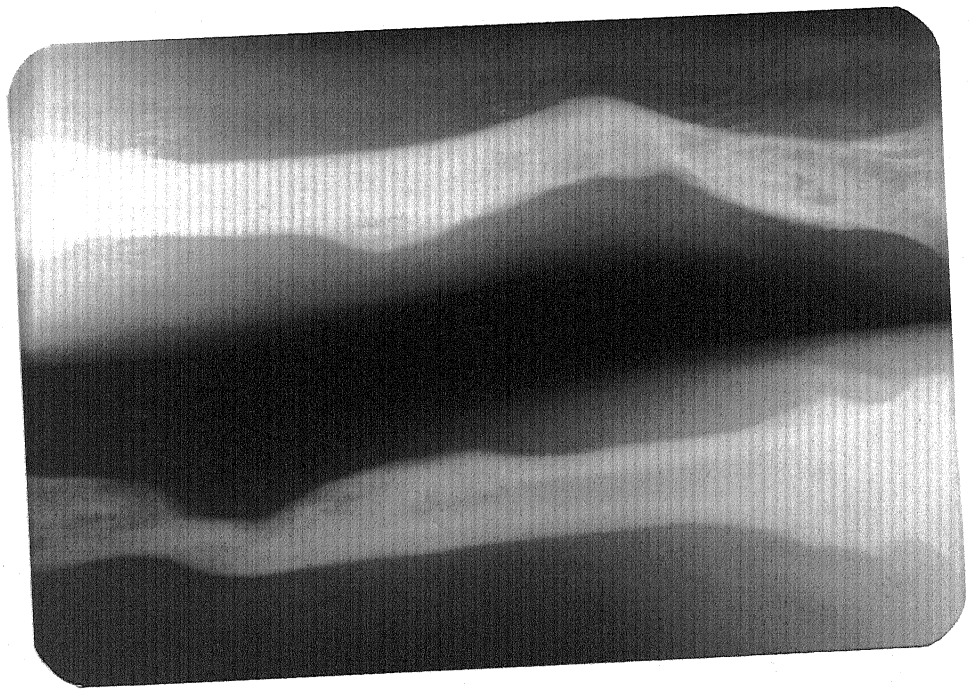


1. Pre-op. A.P. and Lat. skiagram of Rt thigh showing sequestrum with old united pathological fracture of femur.

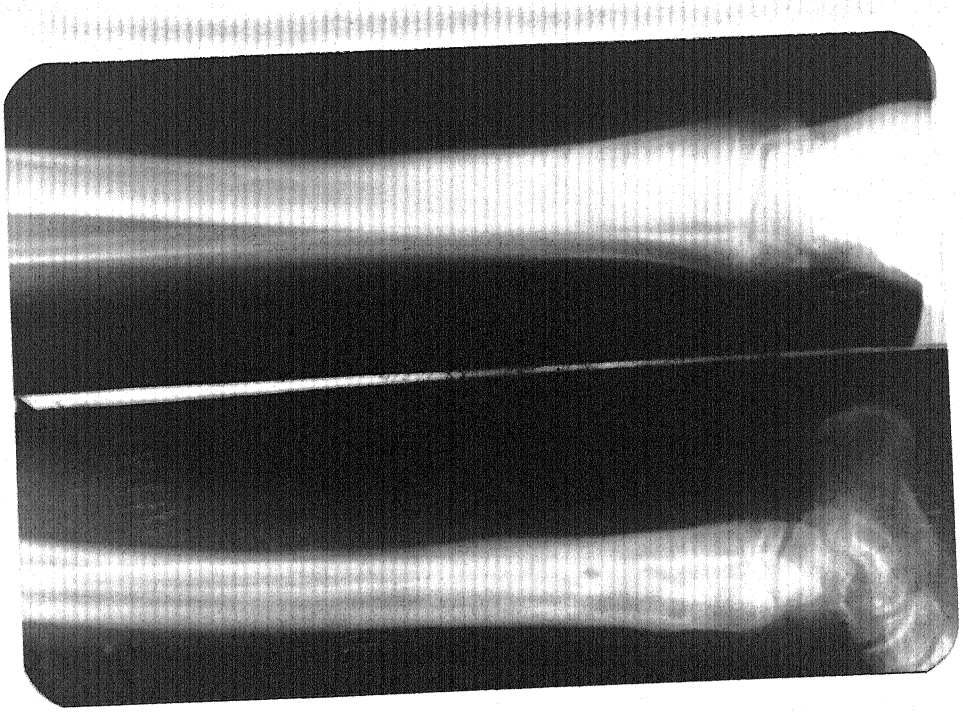


2. Post-op. A.P. and Lat. skiagram of Rt thigh showing both irrigation and suction tubes in position with limb in POP cast.

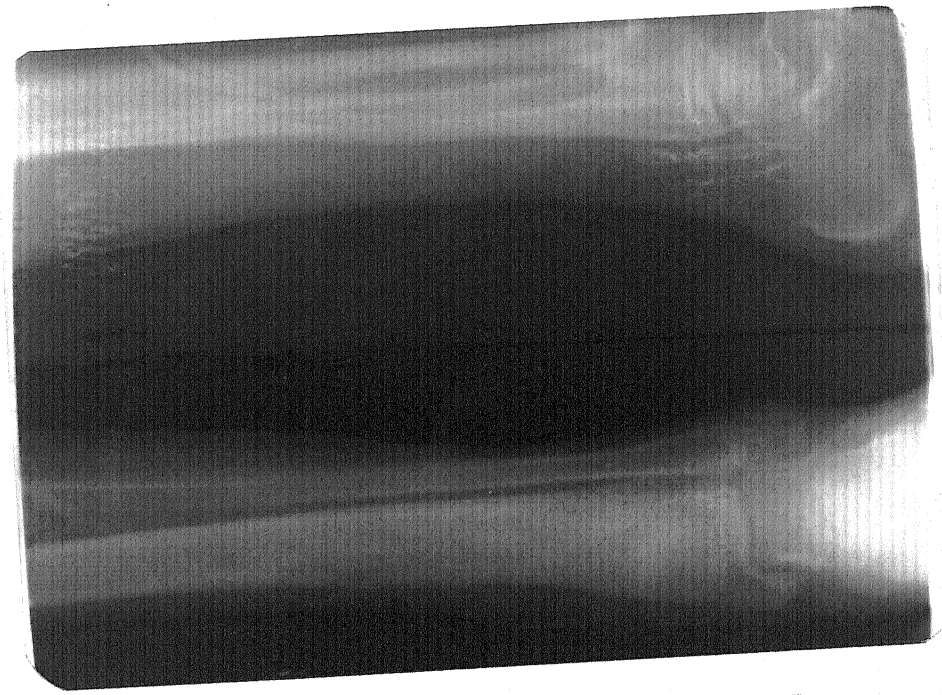
3. Follow-up A.P. and Lat. skiagram of Rt. thigh showing no evidence of residual infection (taken 6 months after operation).



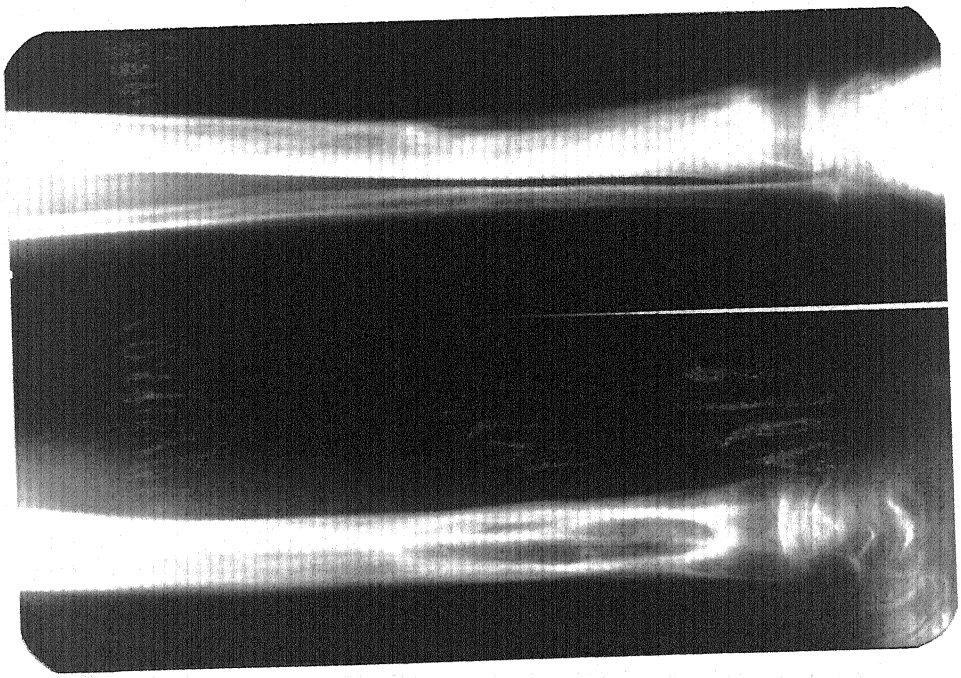
Patient No. 4



1. Pre-op. A.P. and Lat. skiagram of Rt leg showing thickening and sclerosis of lower 1/3 of tibia with cloaca.



2. Post-op. A.P. and Lat. skiagram of Rt leg showing saucerised cavity with both irrigation and suction tubes in place.



3. Follow-up A.P. and Lat. skiagram of Rt. leg showing reduction in cavity size in tibia and no evidence of residual infection (taken 5 months after operation).

DISCUSSION

DISCUSSION

Present study "To evaluate the effect of continuous irrigation and suction technique by using antibiotic solution in the treatment of chronic osteomyelitis" was carried out on 24 cases of chronic osteomyelitis of different bones. Along with above technique conventional methods in the treatment of chronic osteomyelitis, like saucerization, sequestrectomy were also used whenever needed.

Vasty and Waldvogel (1980) observed that haematogenous osteomyelitis is most often seen in childhood. Bajaj et al (1981) found the incidence of haematogenous osteomyelitis 63.33 percent.

In the present study incidence of haematogenous osteomyelitis was 87.50 percent. This is because that most of the patients in our study belongs to lower age groups.

In the present series the patients are ranged from 7-50 years with a mean age of 19.79 years. About two thirds (67.67%) of the cases were below 20 years; being almost same as observed by Rao and Sahu (1978) where 66.67% patients were below 16 years. Many workers observed that osteomyelitis is common in younger age group (Vasty and Waldvogel, 1980). In the series of Bajaj et al (1981) 53.3% patients were in the age group of second decade. This higher incidence of osteomyelitis in younger age group can be ascertained because of haematogenous

mode of spread which is also more common in present series. The another explanation can be the pattern of circulation in the metaphyseal region and greater liability to trauma. (Mercer, 1959).

Out of 24 cases, 21 (87.5%) cases were males and 3 (12.5%) cases were females, this is due to greater susceptibility of males to injury (Mercer, 1959). Similar observations were found in many other series. Males were 77% in the series of Rao and Sahu (1978), 73.3% in the series of Bajaj et al (1981) and 70.36% in the series of Clawson et al (1973).

Out of 24 cases, 18(75%) cases belonged to lower or lower middle socio-economic class. This is because of poor socio-economic conditions of most of population living in Bundelkhand region.

Osteomyelitis is most common in the long bones particularly lower extremities (Waldvogel et al, 1970 and Edeiken et al, 1973). In the present series bones of lower extremities were involved in 75% cases with commonest being femur (45.83%) followed by tibia(25%).

Bajaj et al (1981) reported incidence of osteomyelitis in femur and tibia as 37.9% and 27.6% respectively. Similarly many other workers reported that femur and tibia were most common bones involved in osteomyelitis (Tayler and Maudsley, 1970; Letts and Wong, 1975; Clawson et al, 1973; and Michelinakis, 1972).

In our study duration of illness ranged from 1.5 months to 8 years with the average of 17.88 months. In the series of Clawson et al (1973) average duration of illness was 2.2 years. However in the study carried by Davis et al (1986) average duration of illness was 8.9 years. This would have been because majority of the patients in present study were of younger age group.

Turek (1984) mentioned sinuses as very common clinical feature in chronic osteomyelitis. All cases except one (95.83%) in present series had sinuses.

Haematogenous osteomyelitis is usually caused by gram positive organism, most common being staphylococcus aureus (Aegerter et al, 1975; Waldvogel and Vasty, 1980). Kelly (1977) reported that predominant organism cultured was staphylococcus aureus in about 40% patients of chronic osteomyelitis. In our study staphylococcus aureus was the causative organism in 41.65% cases. In the series of Davis et al (1986) staphylococcus aureus was isolated in 44.74% cases.

Mixed infection in the present study was seen in 2 (8.34%) cases. Kelly (1977) reported incidence of mixed infection 18%. Gram negative bacilli were present in 8(33.33%) cases. This is in line with observation of Kelly et al (1973) that there is a trend of increasing incidence of gram negative bacilli cultured from saucerized osteomyelitis cavities. Identical findings were reported by Bajaj et al (1981). Out of 18 cases of

chronic osteomyelitis gram negative bacilli found in 3(16.7%) (Rao and Sahu, 1978). Gram negative organisms were isolated either alone or in combination in as many as 40% patients (Clawson et al, 1973).

In our series the pus culture from the wound was sterile in 6 cases. Most of the patients had under gone some sort of surgical procedure and almost all of them were receiving some antibiotic before they were subjected to suction-irrigation. This might be the probable cause of absence of organism in culture(Bajaj et al, 1981).

Contamination of suction irrigation system by superinfection is one of the most common complication which occur either on opening the system with use of syringe, change of bottles, or bags of irrigant solution (Clawson et al, 1973). Superinfection was detected by culture of drainage fluid. When organisms cultured are other than the preoperative organisms then it means that superinfection has taken place.

Eight (33.3%) cases in our study had super infection. This is identical (33.3%) to the series of Letts and Wong (1975). The organism most commonly isolated was pseudomonas (16.67%). In the study of Letts and Wong (1975) Pseudomonas was the commonest organism causing superinfection. This is because the gram negative organisms are commonly responsible for hospital acquired infection (Grieco, 1972).

Most frequent problem seen was the blockage of suction tube in 5(21.74%) cases. Constant attention was demanded for first 2 days because during this period problem of clogging was maximum. To avoid this problem we kept the flow rate high for the first 2 days and reversed the suction irrigation system done periodically every few hours. Clogging of the tubes was common even when they were properly utilized, this was due to the fact that the pressure gradient decreases down the tube with the greatest flow occurring through the more proximal holes in the afferent tubes and the distal holes in the efferent tubes. Reversing the flow may not unclog all the holes. When clogging does not disappear the safest way to clean the tubes by the use of a stripping technique. Lubricant was applied to avoid finger burns and to provide a fast high pressure bolus of solution down to the suction tube. During this manoeuvre the patients were explained that they may feel momentary discomfort as the fluid produces internal pressure effect (Clawson et al, 1973).

If the solution runs dry, the tubes could have blocked within minutes and frequently would not work even with stripping. It is never advocated to flush the system by syringing because : even with the best aseptic precautions secondary contamination can occur. Clawson et al (1973) modified the system with a syringe mounted in place. However, we flushed the system with a syringe under full aseptic precautions, whenever stripping technique failed.

Problem of the clogging of the tubes was faced by many other workers (Letts and Wong, 1975; Dilmaghani et al, 1969; Smith-Peterson et al, 1945; Taylor and Maudsley, 1970). All the workers solved the problem by reversing the flow and by flushing.

The causes of the plugging of the suction tubes could be ;

1. Too much "Suction pull" This tends to suck normal tissue down into the tube and thus seal it off.
2. Excessive wound waste in the form of blood and necrotic material.
3. Too little suction. This allows necrotic material to collect in the tube leading to its block.

Too little suction may occur if the tube is displaced and perforated end comes too near to the skin exit, thus allowing an air leak. This can be prevented initially by having a long tract for the tube to traverse, to ensure that all perforations were within the tissues(Taylor and Maudsley, 1970).

Other problems were local pain and swelling. These were secondary to the plugging of suction tube. As outflow is blocked and irrigation fluid continuously entering the cavity thus increasing the pressure inside and resulting local pain and swelling. Problem was automatically solved with the re-establishment of irrigation-suction system. Similar problems were seen by many other workers (Dilmaghani et al, 1969; Smith-

Peterson et al, 1945; Letts and Wong, 1975; Clawson et al, 1973; Taylor and Maudsley, 1970).

In the present series 5(21.74%) cases developed the problem of blockage of suction tube.

Leaking was another common problem in 4(17.36%) cases which can be explained by :

1. Repeated clogging of the suction tube resulting to increased pressure inside the cavity and thus gapping of the stitch line.
2. Displacement of the tubes thus bringing perforated ends too near to the skin exit, which could be avoided by tight anchorage and deeper insertion of tubes.

Many other workers faced the same problem and were able to solve in the same way (Smith-Peterson et al, 1945; Dilmaghani et al, 1969; Taylor and Maudsley, 1970; Clawson et al, 1973; Letts and Wong; 1975). In 1 case leaking was very much because of gapping of theskin and exposure of the bone and we had to discontinue the irrigation-suction technique.

In 1(4.36%) case patient himself accidently pulled the tube which was reinserted after re-opening the wound in operation theatre. This has also been reported by(Letts and Wong, 1975 and Michelinakis,1972).

In the present study complications were seen in 7(30.44%) cases and remaining 16 (69.56%) cases were problem free.

In the present study duration of irrigation-suction technique ranged from 6-21 days with the average of 13.17 days. In about half of the cases (47.91%) irrigation was continued for 11-15 days. It was difficult to know how long the tubes should be left in the wound. We kept the tube inside till two consecutive cultures of drainage fluid found to be sterile. Clawson et al (1973) kept the tubes inside till the dead space obliterated. They took the help of sinography for determination of dead space. They thought that cultures of the egress fluid is not a satisfactory criteria for removal of the tubes as positive cultures may indicate cross contamination from technical breakdown in the system. Under these circumstances, the bacteria may be growing in the tube system and not be pathogenic in the host. In their series irrigation was continued for 5 to 40 days (80% of the tubes removed between tenth and twenthieth day).

Bajaj et al (1981) used same criteria for the removal of the tubes as used in our series and the duration of irrigation (4-14 days) was comparable to our study. Rao and Sahu (1978) also used same criteria for the removal for tubes.

Dombrowski and Dunn (1965) reported adequate duration of irrigation as 3 to 4 weeks. They explained this duration on the basis that at least this much time was required to organise the haematoma filled dead space with granulation tissue. However they have continued

irrigation for 1 week after 3 consecutive negative cultures have been obtained.

Letts and Wong (1975) used closed tube irrigation in their series for 4-40 days with average of 13.5 days. However in the series of Taylor and Maudsley (1970) irrigation was continued for upto 6 weeks.

In our study amount of normal saline used for irrigation in different cases ranged from 1120 ml to 1600 ml per day with the average of 1363.8 ml per day. 1300-1400 ml normal saline per day was used in 10(43.48%) cases. We kept the flow rate of the irrigation solution high. This not only helped to prevent sludging during the early part of the irrigation but also might be essential to the mechanism of function of the procedure (Dombrowski and Dunn, 1965). During the first few days of irrigation, a high flow rate was required to prevent clogging of the suction tube. This is because bleeding inside the cavity was significant and thus enhancing the chances of clogging of the tubes. This theory is supported by many other workers (Dombrowski and Dunn, 1965; Taylor and Maudsley, 1970 and Clawson et al, 1973).

Different workers kept the flow rate of the irrigation solution as follows :

1.	Dombrowski and Dunn (1965)	2-3 Lt/day/tube
2.	Compere (1962)	2 Lit/day
3.	Michelinakis (1972)	2 Lit/day
4.	Taylor and Maudsley (1970)	1000-1500 ml/day

5.	Rao and Sahu (1978)	1000-1500 ml/day
6.	Bajaj et al (1981)	1000-1500 ml/day
7.	Clawson et al (1973)	1-2 Lit/hr for first two days.

Amount of irrigation solution used by most of the workers ranged from 1-2 Lit/day. Only Clawson et al (1973) used the irrigation solution in very high amount but they did not used antibiotics in the irrigation fluid.

Antibiotics were used in the irrigation fluid according to the culture report of the drainage fluid. Combination of crystalline penicillin and Gentamicin were used. Other antibiotics used were - Streptomycin, Cephazoline, Ampicilline and Chloramphenicol. Basis behind the use of antibiotics in the irrigation fluid was the delivery of effective antibiotics to the infected region in high concentration with minimum systemic distribution (Dilmaghani et al, 1969).

Besides the local antibiotics we also used systemic antibiotics.

Combination of local and systemic antibiotics was used by many other workers viz. Rao and Sahu (1978), Bajaj et al,(1981), Dilmaghani et al (1969), Compere (1962) and Smith-Petersen et al (1945).

However, many workers used detergent or wetting agent along with irrigation fluid (Compere, 1962; Michelinakis, 1972; Dilmaghani et al, 1969; Mitra and Grace, 1956-57).

Post-operative hospital stay of the patients in our study ranged from 14-40 days with the average of 22.26 days. Fourteen (60.81%) cases had post-operative stay of less than 3 weeks. It indicates that post-operative stay with this technique was very brief. Same conclusion was drawn by many other workers (Smith-Petersen et al, 1945; Dombrowski and Dunn, 1965; Rao and Sahu, 1978 and Bajaj et al, 1981). However, Letts and Wong (1975) reported in their study that children treated with closed tube irrigation required a period of post-operative hospitalisation almost twice as long as that of the control group. But difference in this study was that they used the technique for the treatment of acute osteomyelitis in children. Moreover they themselves emphasised that closed-tube irrigation is an excellent method of treating chronic osteomyelitis.

Brief post-operative stay ensures excellence of the technique for primary healing of the wound.

In our study duration of follow up ranged from 4 to 11.5 months with the average of 6.76 months. Rao and Sahu (1978) followed the patient for almost same duration (7-9 months). Taylor and Maudsley (1970) followed their patients for at least 1 year. Dombrowski and Dunn (1965) followed their patients for the period of at least 6 months. Dilmaghani et al (1969) followed their patients for the period of 2 years.

Different workers used various criteria for the evaluation of the results. We used definite clinical and

radiological criteria which were same as used by Bajaj et al (1981) for the assessment of the results in three grades i.e. excellent, good and poor.

Excellent

When there was healing by primary intention without any sinus, infection, pain or local tenderness.

Good

When there was delayed wound healing, occasional pain and tenderness but without discharge, sinus or radiological evidence of infection.

Poor

When there was persistant pain or discharge with radiological evidence of infection or formation of sequestrum.

With above criteria results in our study were as follows :

Excellent in 14 (60.87%) cases.

Good in 5 (21.74%) cases.

Poor in 4 (17.39%) cases.

Different criteria were used by other workers e.g. Rao and Sahu (1978) evaluated their results as "Successful" and "FAilure".

Many workers evaluated their results according to recurrence of infection. If no recurrence then they considered result as good (Compere, 1962; Michelinakis, 1973; Dilmaghani et al, 1969; Smith-Petersen et al, 1945; Letts and Wong, 1975; Taylor and Maudsley, 1970).

Domborwski et al (1969) encouraged with the short term results of closed irrigation-suction technique. They compare their short term results with these obtained by the open packing method in another series. Passage of 6 months without recurrence of drainage was taken arbitrarily as the criterion for comparison.

Clawson et al (1973) in their series evaluated results by following 3 parameters : drainage, pain and toxic condition. The patient's condition on follow up was compared to their pre-operative condition and change noted in the 3 parameters and results were evaluated.

COMPARISON OF SUCCESS RATE

Author	Year	Total No. of cases	Result (Success) in percent
Grace and Bryson	(1945)	3	100.00
Mitra and Grace (1957)	(Calcutta)	95	64.21
	(Brooklyn)	45	69.00
Goldman et al	(1960)	5	100.00
Dombrowski and Dunn	(1965)	20	77.00
Dilmaghani et al	(1969)	24	87.50
Taylor and Maudsley	(1970)	12	66.70
Michelinakis	(1972)	12	83.33
Clawson et al	(1973)	176	74.00
Rao and Sahu	(1978)	18	77.70
Bajaj et al	(1981)	30	73.30
Present series	(1987-88)	23	82.61

The treatment of chronic osteomyelitis is very cumbersome, time consuming and unsatisfactory till date which signifies from the fact that several attempts to cure it have been made starting from boiling water to various reconstructive operative procedures, but none is foolproof.

All conventional methods available at present had one common aspect i.e. removal of dead tissue and sequestra excision of sinuses and saucerization. The dead space thus left behind is filled up by the haematoma which serve as potential site of the infection.

By using continuous irrigation-suction technique this problem is solved.

Moreover, effective antibiotics can be delivered to infected region in high concentration with minimal systemic distribution by adding them in irrigation fluid. Otherwise antibiotics could not reach at the site of infection because of the relative avascularity of bone and inability of antibiotics to transgress the area occupied by necrosed tissue and pus.

Other advantages with continuous irrigation suction technique includes - Almost complete primary closure of the wound which is not possible with other methods and thus resulting to a minimum loss of serum from the epithelial surface. This is important because the loss of serum protein can be considerable, as was demonstrated by Smith-Petersen et al (1945) by treating 1 case by the method of "Packing and wound open". The determined loss of serum

protein for a period of 24 hours amount for 36.9 grams; the average daily loss over a period of a week was 11.9 gms.

The infrequency of dressings appeals the patients and to the surgeon. Septic dressings are painful no matter how gently they are done, and they are bound to be time consuming.

The time for the complete healing of the wound is shorter and scar remain linear and smooth, instead of broad and puckered (Smith-Petersen et al, 1945).

Dombrowski and Dunn (1965) reported requirement of irrigation system as follows :

1. Air tight and water tight wound closure - This prevents skin maceration, reintroduction of new organisms.
2. Placement of irrigation tubes wherever necessary.
3. Keeping multiperforated ends of the tubes short (3 or 4 inch) because when fluid is in motion there is a constant fall in hydrostatic pressure along the perforations distally (Binder, 1949). There is also a constant fall in negative pressure distally along such perforated suction tubes. When tubes are long clots form distally, migrate proximally, ultimately plugging the system.
4. Keeping the flow rate of the irrigation solution high this prevents plugging of tubes.
5. Adequate duration (2-3 weeks) of irrigation discontinued when 2 consecutive cultures become negative.

6. Use of appropriate systemic and local antibiotics - according to culture reports.
7. Good nursings and house staff are essential because constant attention is necessary for the first 2 days and it is impossible for a surgeon to manage the suction irrigation system himself (Clawson et al,1973).

Smith-Petersen et al (1945) reported that :

- This is not a perfect method with 100% cures. There had been cases with local recurrence of sepsis, but these had been relatively few.
- The suction and irrigation system is not immune to clogging. But a change in the direction of the irrigation fluid and flushing the wound usually eliminate obstructions without much difficulty.
- Leaking is also a problem but this can be solved by air tight and water tight wound closure.

Closure of the wounds with irrigation and drainage were first reported by Smith-Petersen et al (1945). In 1956 Mitra and Grace treated osteomyelitis by instillation of penicillin and a detergent through catheter into the wound. In 1060, Goldman et al and in 1961 Mc Elvenny described the use of a circulation suction method of treating infected wound and osteomyelitis. To improve the function of the system and to enhance the antibacterial effects of the solution, Compere (1962) recommended the addition of tyloxapol (Aleyaire) to irrigating fluid. In

1965 Dombrowski and Dunn used streptokinase - Streptodornase (Varidase) and in 1969 Difloghani et al used chlorpactin XCB in the suction irrigation. Clawson et al (1965, 1973) modified the previous tubing system in closed suction irrigation technique.

Dombrowski and Dunn (1965) postulated the following explanation of why prolonged irrigation may seen to substitute atleast in part even for inadequate debridement. Irrigation solution composed of physiologic saline and antibiotics (Osmotic pressure of about 30 mm of Hg) are hypertonic with respect to interstitial fluid (Osmotic pressure of about 15 mm of Hg). There is an osmotic gradient of 15 mm of Hg. inducing a flow of fluid from tissue to wound cavity. The second factor which helps the flow of fluid is the temperature. The lower the temperature the greater the osmotic pressure. The tissue temperature is about 37°C and the temperature of cavity is about 25°C (Temperature of irrigating system at room condition). Thus there is again a gradient favouring flow of fluid from local tissue to wound cavity. This flow brings fresh lymph and leucocytes into the area which have antibacterial property and help in obliteration of dead space.

Closed suction irrigation technique incorporates all previous principles of treatment, with the patient at bed rest and host defences mobilised. Radical debridement eliminates involved dead and devitalised tissue. Dead space haematoma is controlled by irrigating solution by

certain possible physiologic mechanism, as postulated by Dombrowski and Dunn (1965). Primary closure of skin and soft tissues prevent cross contamination and recontamination. The presence of antibiotics through irrigation solution aids local host mechanism. High concentration of local antibiotic infusion controls any septic process persisting in the area.

Poor result from the use of closed irrigation suction is usually from one or more causes as stated by Clawson et al (1965, 1973).

Inability to remove all the dead bone and surrounding scar tissue :

- Failure to understand the principles of suction irrigation system.
- Technical failures of the surgical and nursing team.

The advantages of suction-irrigation technique can be summarised as follows :

1. Almost complete prediction that the operative wound will heal by primary intention.
2. Infrequency of dressing.
3. Reduction in the time for complete healing.
4. Minimum loss of serum.
5. No soiling of bed linen.
6. Comfort and lack of systemic reaction.
7. Reduction in cross infection, hospitalization and post-operative isolation.

8. Metalic intramedullary fixation may be left in place or inserted at the time of operation.

Most important limitation with this technique is that it cannot be used in the treatment of osteomyelitis of short bones.

Though observation period is short and the material is small, but on the basis of results achieved and comparing the results with other similar series it is justified to recommend, the use of continuous irrgiation suction by using antibiotic solution in the treatment of chronic osteomyelitis.

CONCLUSION

C O N C L U S I O N

Continuous irrigation-suction technique by using antibiotic solution is an excellent mode of treatment for chronic osteomyelitis, when used as an adjuvant to radical excision of unhealthy tissue and administration of effective antibiotics. Irrigation with antibiotic solution serve dual purpose. Firstly, it prevents haematoma formation and secondaly high concentration of antibiotics reaches at local site.

In the present study following conclusions are drawn :

1. Younger ones ($\leq$ 20 years) are affected by osteomyelitis more than older ones.
2. Males are more commonly affected than females. Male, female ratio being 7 : 1.
3. Haematogenous spread is common mode of infection.
4. The prevalence of disease is commoner in lower socio-economic group as 75% cases are from lower and lower middle class.
5. Lower limb is more prone to disease rather than other sites.
6. The usual clinical feature presented are bone pains, tenderness, pus discharge and non healing wounds.
7. Radiological signs commonly seen are localised sclerosis, disfigured out line, destruction, periosteal reaction, sequestration and sinuses.

8. Staphylococcus aureus is commonest organism causing osteomyelitis.

9. Pseudomonas is commonly seen causing superinfection.

10. Common problems found in the present technique are leakage, plugging and swelling secondary to plugging. These problem can be easily controlled.

11. High rate of irrigation flow is required to prevent plugging. Air-tight closure of wound is necessary to prevent leaking.

12. 1100-1600 ml normal saline is the usual volume required for irrigation.

13. Appropriate duration of irrigation should be 2-3 weeks.

14. Crystalline penicillin and gentamicin are found to be most effective antibiotics in the treatment of osteomyelitis.

15. Radical excision of all devitalised soft tissue and dead bone followed by instillation of continuous irrigation and suction technique by using antibiotic solution has shown good or excellent results in 82.61% cases with failure in 17.39% cases.

16. Incomplete removal of sequestrum, dead tissue, presence of superinfection, resistant infection are commonest causative factors for failure of technique.

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APPENDIX

APPENDIX

TO EVALUATE THE EFFECT OF CONTINUOUS IRRIGATION AND SUCTION TECHNIQUE BY USING ANTIBIOTIC SOLUTION IN THE TREATMENT OF CHRONIC OSTEOMYELITIS

Case No. MRD No.

Name Age/Sex Ward/Bed

Father's/Husband's Name Occupation

Address D O A

D O D

Diagnosis

Consultant

Chief Complaints

History of present illness

History of Past Illness

Family History

Personal History

Socio-economic status

General Examination

Appearance	Anaemia
Built	Cyanosis
Pulse	Clubbing
B.P.	Jaundice
R/R	Oedema
Lymph nodes	General
	Local

Systemic Examination :

CVS

CNS

Resp.

Abdomen

Local Examination

1. Number of healed sinuses.
2. Number of discharging sinuses.
3. Operation scar mark.
4. Movements — Joint Above — Joint Below

   Abduction

   Adduction

   Medical rotation

   Lateral rotation

   flexion

   Extension

   Circumduction

   Inversion

   Eversion
5. Nerves -

   Radial N. — Median N. — Ulnar N.

   Sciatic N. — Lateral Popliteal N.
6. Vascular Supply -

   Brachial artery

   Radial artery

   Popliteal artery

Dorsalis pedis artery

Posterior tibial artery

7. Bony Thickening

8. Tenderness

Radiological Examination

Periosteal reaction	Sequestrum
Destruction	Sclerosis
Mottling	Thickening
Cavity	

Investigations

Blood TLC DLC : P L E

N B

ESR Hb

Urine Albumin Sugar M/E

Blood Urea

Blood Sugar : F

PP

Pus Culture & Sensitivity

Treatment

1. Pre-operative -

- ATS
- Tet. Vac.
- Antibiotic- Total No. of days : (i)

(ii)

2. Operative Treatment -

. Date of Operation

. Type of Operation

Surgeon

Assistants

Anaesthesia Op. Steps

Remarks

3. Post-Operative Treatment-

. Date of removal of stitches (i)

(ii)

. Type of immobilisation (A) Postoperative

(B) At the time of Discharge.

. Duration of immobilisation (A)

(B)

Remarks

Follow up

(i) Clinical Examination Date:

(ii) X-ray

(iii) Movement - Above Joint

Below Joint

(1) Healing			
(2) Pain			
(3) Tenderness			
(4) Sinus			
(5) Residual Infection			

Result

Summary

IRRIGATION-SUCTION DETAILS

Sl. No.	Date	Fluid used	Amount	Antibiotic used 1	Antibiotic used 2	Systemic Antibiotic 1	Systemic Antibiotic 2	Remarks
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								
14.								
15.								

PUS CULTURE REPORTS

S.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date															
Organism															
Ampicillin															
Gentamycin															
C.P.															
Streptomycin															
Terramycin															
Chloromycetin															
Erythromycin															
Kanamycin															
Cloxacillin															
Cephalexin															
Polymyxin-B															

SUMMARY

S U M M A R Y

The present study "To evaluate the effect of continuous irrigation-suction technique by using antibiotic solution in the treatment of chronic osteomyelitis was carried out on 24 patients of proved chronic osteomyelitis of different bones, admitted in Orthoaedic ward of M.L.B. Medical College, Hospital, Jhansi between July, 1987 and June, 1988. Out of 24 patients 1 patient died post-operatively due to flaring up of septicemia and bactarimia.

The criteria for selection of cases were pain, discharge, tenderness and thickening with radiological evidence suggestive of chronic osteomyelitis.

After admission these cases were thoroughly examined clinically and radiologically. Various relevant investigations were done prior to surgical intervention. According to pus culture and sensitivity report proper antibiotic coverage was given and surgery was performed in the form of saucerization, sequestrectomy, curettage, excision of sinus tract followed by placement of irrigation and suction tubes inside the cavity under general or regional anaesthesia. Irrigation-suction technique was checked per-operatively.

The limbs were properly supported either in slab or splint and patients were shifted to post operative ward. Patients and irrigation suction technique were closely watched post-operatively and any problem if arised was solved accordingly.

After stitch removal pain and tenderness were reduced considerably in most of the cases.

These patients were followed up at regular intervals to evaluate clinically and radiologically. On the basis of these observations and evaluation results were categorised in the following three grades i.e. excellent, good and poor.

Excellent - when there was healing by primary intension, no sinus or residual infection. No pain or local tenderness, no radiological evidence of infection.

Good - when there was delayed wound healing or occasional pain and tenderness but no discharge or sinus and no radiological evidence of infection.

Poor - when there was persistent pain or discharge or radiological evidence of infection or formation of sequestrum.

In present study of 24 cases of chronic osteomyelitis most of the patients were in the age group of 11-20 years (with mean age of 19.79 years). Marked male predominance (87.50%) was observed due to their more outdoor activities. Commonest mode of spread of osteomyelitis was haematogenous.

Bones of lower limbs involved more (75%) with femur as commonest site (45.83%). The duration of illness in these patients ranged from 1½ months to 8 years. It was observed that most of the patients had

undergone some sort of treatment before this study (chemotherapy alonge or alongwith incision and drainage).

Sclerosis, thickening, destruction, sequestrum, periosteal reaction and cavities are the common radiological features. Staphylococcus aureus was the commonest organism isolated from 10(41.65%) cases followed by Pseudomonas (12.50%). Commonest organism responsible for superinfection was Pseudomonas (16.67%). 8(33.3%) cases showed superinfection while in 16(66.7%) cases there was no superinfection.

Along with irrigation and suction one or more of the following procedures was carried out viz. curettage, syringectomy drill holes, saucerization, sequestrectomy.

Gaping of the stitch line, sloughing of skin and persistant discharge after operation were the complications observed.

Problem with irrigation-suction technique includes plugging of suction tubes, leaking, swelling and pain at local site. All the problems were controlable. In 7(30.44%) cases these problems were seen while rest 16 (69.56%) cases were problems free.

We kept irrigation flow rapid for first 2 days to avoid the problem of clogging. 1200-1600 ml normal saline was used for irrigation per day. Duration of irrigation ranged from 6 to 21 days. Crystalline penicillin and gentamicin were the choice of antibiotics used in irrigation fluid.

Post-operative hospital stay of the patients ranged from 14-40 days with the average stay of 22.26 days. Fourteen (60.87%) cases remained in the hospital for less than 3 weeks.

In present series, follow up of patients was ranged from 4 to 11.5 months with the average of 6.76months.

In this study results were excellent in 14 (60.87%) cases, good in 5(21.74%) cases and poor in 4(17.39%) cases. Thus results were favourable in 82.61% cases.

In one case irrigation was discontinued because of sloughing of the skin and exposure of the bone while in one case recurrence of infection was seen.

Causes of the poor results includes inability to excise all dead and devitalized tissue and technical failures.

On the basis of this study, it is concluded that continuous irrigation suction technique by using antibiotic solution is an excellent method to treat chronic osteomyelitis, when used as an adjuvant to radical excision of unhealthy tissues and administration of effective antibiotics.

Advantages of irrigation suction technique are:

1. Haematoma formation in the dead space is prevented thus minimising the chances of reinfection.
2. High concentration of antibiotics reached at local site.
3. Primary closure of the wound is almost certain.
4. Minimal loss of the serum.
5. Post-operative hospital stay is of short duration.